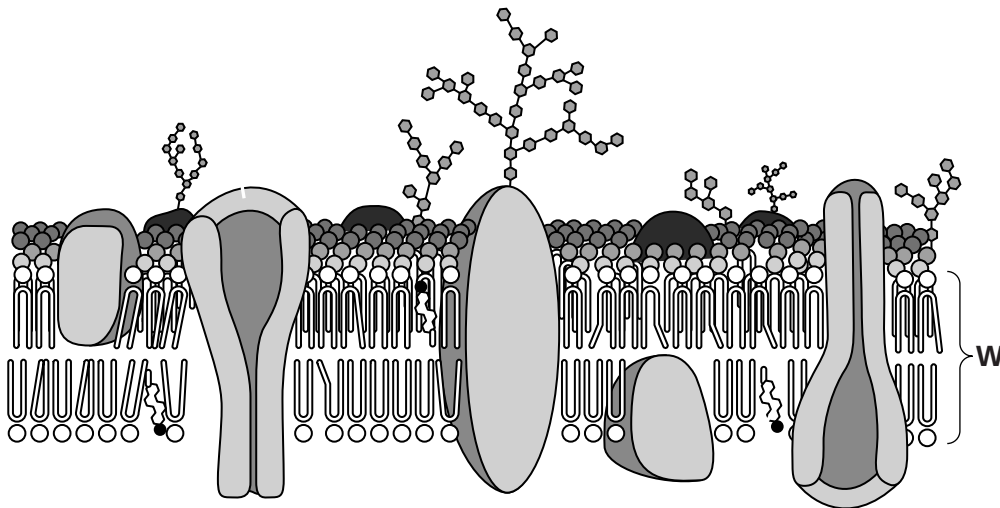


A LEVEL Biology

4. Cell Membrane & Transport

Paper 2



2012-2025

Classified by Mr. Adeel Ahmad

4. Cell Membrane & Transport

9700/22/M/J/12

- 1 One role of the cell surface membrane is to control the entry and exit of substances.
- (a) Complete Table 1.1 to show the transport mechanisms across cell surface membranes and examples of materials transported.

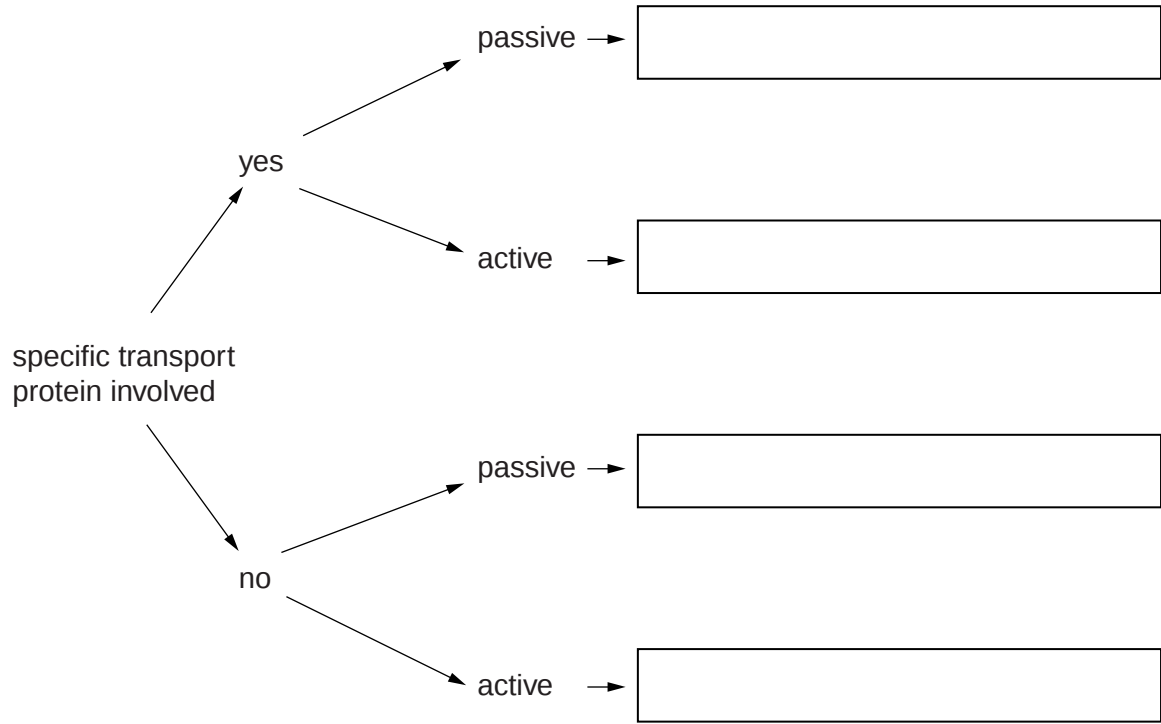
Table 1.1

transport mechanism across cell surface membrane	example of material transported across membrane
active transport	sodium ions
	oxygen molecules
	bacteria
exocytosis	mucin (for mucus)
facilitated diffusion	
osmosis	

[2]

- (b) Each transport mechanism across cell surface membranes has a characteristic set of features.

In **each** of the boxes below, state **one** example of a transport mechanism that matches the pathway shown.



[4]

[Total: 6]

- 3 The cholera toxin interacts with ion channels in the epithelial membranes, resulting in watery diarrhoea.

These channels open, allowing ions to move from the epithelial cells into the lumen of the intestine.

- (b) (i) Name the process by which the ions move in this case.

..... [1]

- (ii) Due to the movement of ions into the lumen, water moves from the epithelial cells into the lumen.

Name the process by which water moves and explain why it moves into the lumen.

name

explanation

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..... [3]

- 2 The fluid mosaic model of membrane structure was first proposed in 1972 by Singer and Nicolson. The model describes in detail how the components of a membrane are organised.

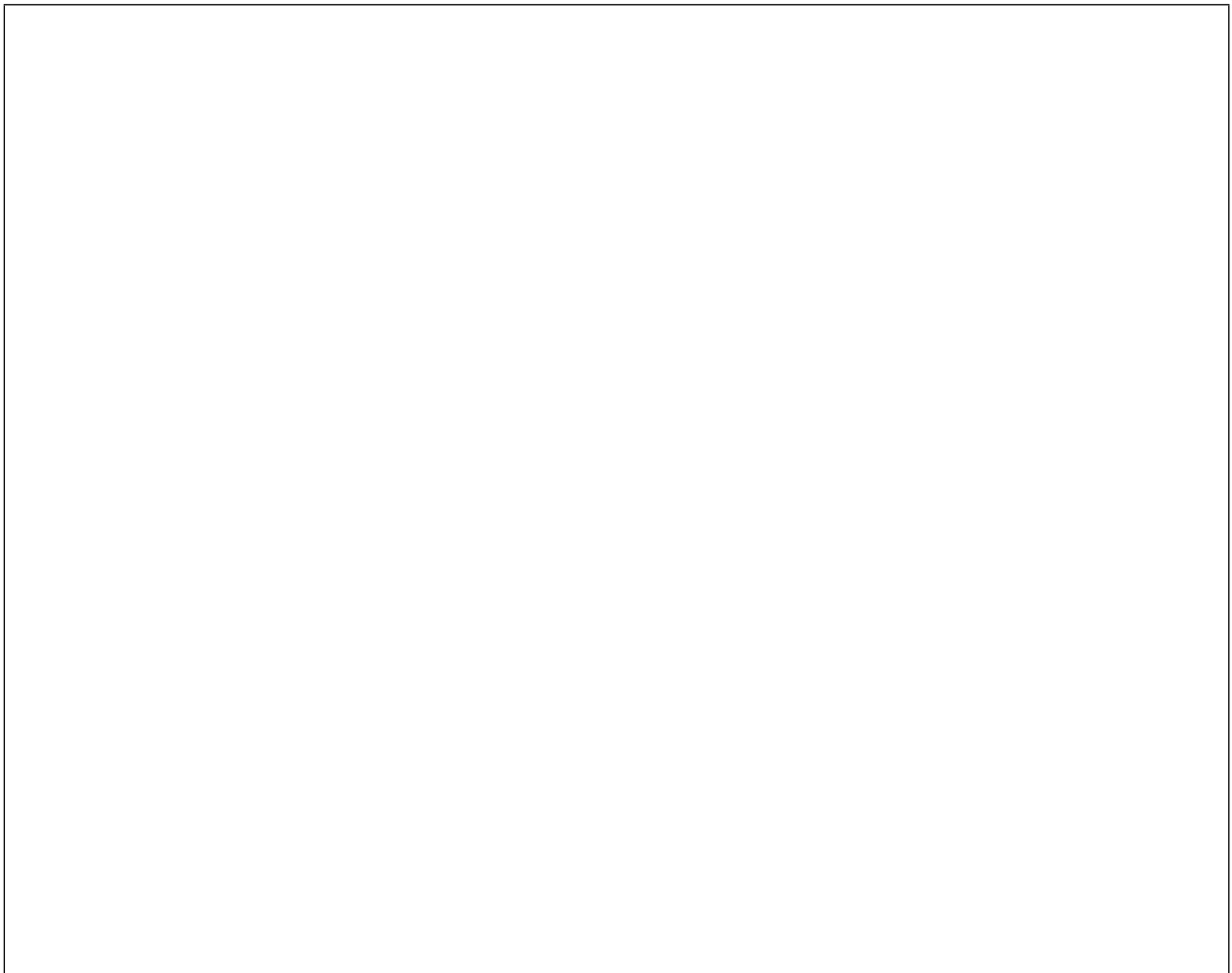
(a) Some of the components of the cell surface membrane are:

- phospholipid molecules
- protein molecules
- cholesterol molecules.

- (i) In the box below, draw a labelled diagram of a section through a cell surface membrane to show how the above components are organised within the membrane.

The diagram should include other named components of the membrane.

Label the inner and outer surfaces of the membrane.



[5]

- (ii) Suggest why 'fluid mosaic' is an appropriate term to use to describe membrane structure.

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..... [3]

[Total: 8]

5 Fig. 5.1 shows a section of a cell surface membrane.

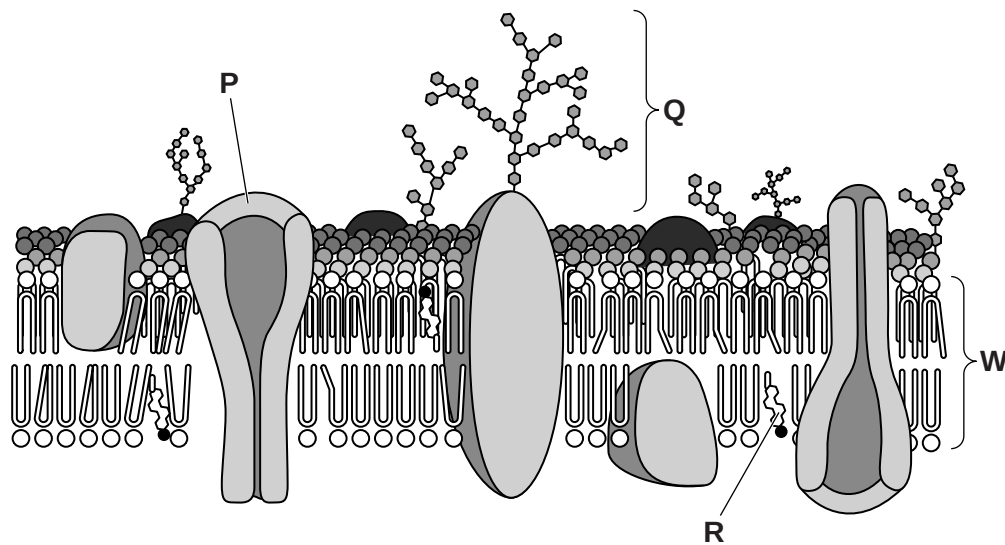


Fig. 5.1

(a) State the functions of structures **P**, **Q** and **R**.

P

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Q

.....

R

..... [3]

(b) Circle the width of the membrane shown as **W** in Fig. 5.1.

17.0 μm 1.7 μm 0.7 μm 70.0 nm 17.0 nm 7.0 nm 0.7 nm [1]

(c) Membranes, such as the cell surface membrane, are described as having a fluid mosaic structure.

Explain what is meant by the term *fluid mosaic*.

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..... [2]

- (d) Aquaporins are membrane channel proteins in plant and animal cells. They permit the movement of water across membranes. Explain why they are necessary.

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..... [3]

[Total: 9]

9700/22/M/J/13

In some organisms, trehalose is used as an energy store and gives protection against the harmful effects of very low temperatures. Trehalose is sometimes referred to as a cryoprotectant, allowing organisms to survive in freezing conditions.

Freezing temperatures can damage the cell surface membrane and membranes within the cell.

(c) Explain the importance of the cell surface membrane to cells.

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..... [3]

- 1 (c) The membrane surrounding the vacuole, called the tonoplast, has a fluid mosaic structure.

Describe the structure of this membrane.

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..... [4]

- (d) Palisade mesophyll cells have very large vacuoles.

Explain how water moves from the xylem in the leaf into these vacuoles.

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..... [3]

- (b) Bacterial cells behave in a similar way to plant cells when immersed in solutions of different water potential.

Suggest **and** explain what would happen to bacteria placed in a solution with a water potential more negative than their cell contents.

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..... [3]

- 5 (c) Digested material in animals is absorbed using both facilitated diffusion and active transport.

State two similarities **and** two differences between facilitated diffusion and active transport.

similarities:

1.

2.

differences:

1.

2.

[4]

[Total: 13]

- (b) The bacteria take in glutamic acid by active transport.

Describe the process of active transport.

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.....[3]

Glucose can enter cells by active transport or facilitated diffusion.

Glucose-6-phosphate is a charged, polar molecule and cannot move out of cells.

(d) (i) State two **differences** between active transport and facilitated diffusion.

1.

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2.

.....

[2]

(ii) Suggest why glucose-6-phosphate cannot move out of cells.

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..... [2]

[Total: 12]

(b) Cells in the pancreas secrete enzymes, such as amylase and trypsin, into a duct.

The enzymes are packaged in vesicles so that they can be exported from these cells as shown in Fig. 5.2.

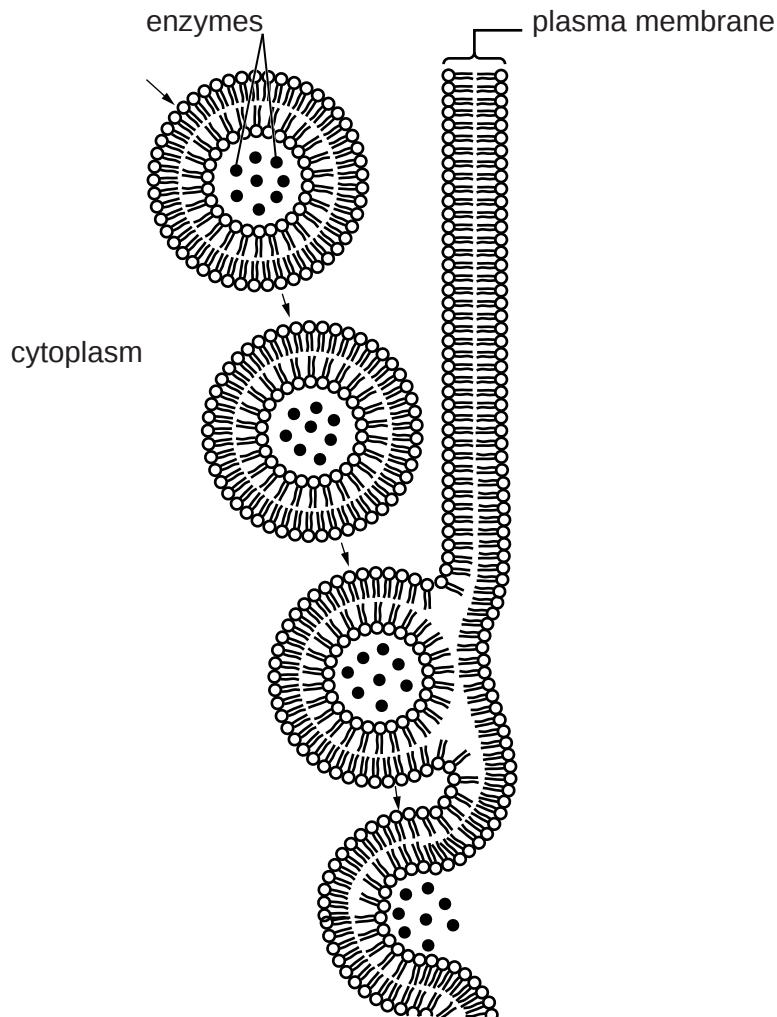


Fig. 5.2

With reference to Fig. 5.2, explain how enzymes that are secreted by cells in the pancreas are packaged into vesicles and exported.

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.....[4]

- 3 Outside the body, red blood cells can be maintained in an intact state by keeping the cells in a 0.9% solution of sodium chloride. This is known as a normal saline solution.

Fig. 3.1 shows intact red blood cells.

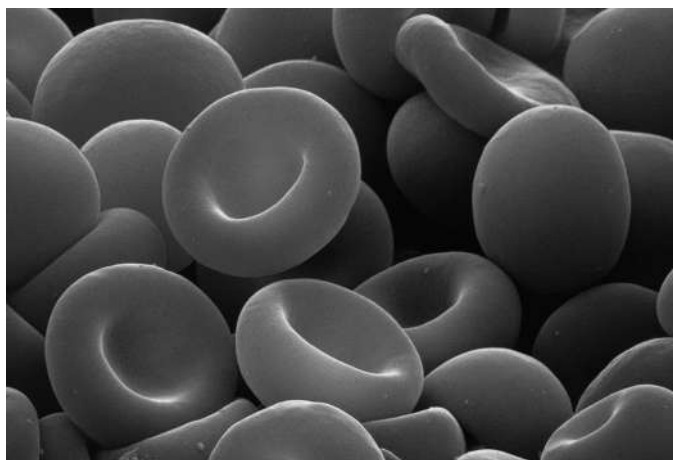


Fig. 3.1

- (a) Explain why red blood cells can be maintained in an intact state by keeping them in a normal saline solution.

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.....[2]

- (b) In the blood, red blood cells are suspended in plasma. The main component of blood plasma is water.

Suggest **one** other component of blood plasma that could enter red blood cells **and** describe how it would cross the cell surface membrane.

component

description

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.....[3]

Answer **all** the questions.

- 1 The cell surface membrane has a fluid mosaic structure.

(a) Describe what is meant by the term *fluid mosaic*.

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.....[2]

- (b) In 1934, the biologists Davson and Danielli published their suggestion for the structure of the cell surface membrane, as shown in Fig. 1.1.

They suggested that the membrane was a phospholipid bilayer with a layer of hydrophilic protein on both surfaces.

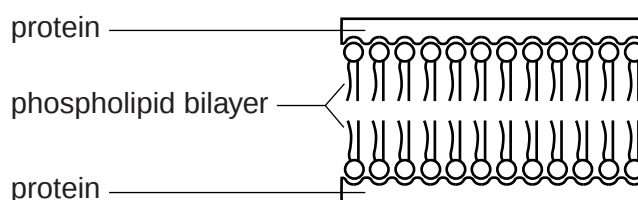


Fig 1.1

State **one** way in which the Davson-Danielli structure is similar to the fluid mosaic structure **and one** way in which it differs from the fluid mosaic model.

similarity

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.....[1]

difference

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.....[1]

- (c) One way in which substances can cross cell membranes is by active transport.

Describe the mechanism of active transport.

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.....[3]

- (d) High temperature can damage cell membranes. One factor contributing to this damage is the denaturation of membrane proteins.

Describe how proteins become denatured at high temperature **and** explain how this could lead to damaging cell membranes.

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.....[3]

[Total: 10]

2 Fig. 2.1 is a diagram of the structure of a protein channel for ions in a cell surface membrane.

Fig. 2.1a shows the channel when open and Fig. 2.1b shows the same channel when closed.

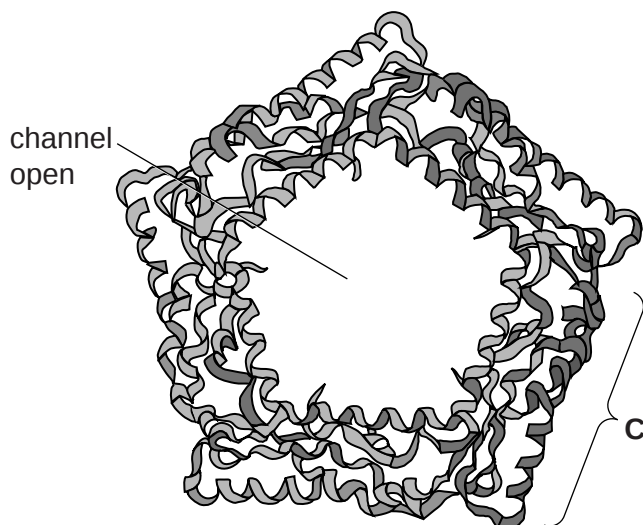


Fig. 2.1a

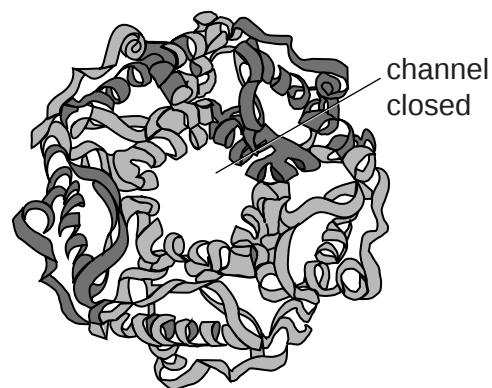


Fig. 2.1 b

(a) (i) Name the process by which ions pass across the membrane using channel proteins.

..... [1]

(ii) Explain why a channel protein is needed for ions to pass across a cell membrane.

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..... [2]

(b) The channel protein in Fig. 2.1 is made from five identical polypeptide chains.

- (i) Name the level of protein structure which is present when five polypeptide chains form the protein.

..... [1]

- (ii) The part labelled **C** in Fig. 2.1 is another level of protein structure.

Name this level.

..... [1]

- (c) Channel proteins are examples of transmembrane proteins. The polypeptides are held together and also interact with phospholipids in the membrane.

Suggest how the polypeptides are held together **and** suggest how they interact with phospholipids.

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..... [3]

[Total: 8]

- 4 (a) Table 4.1 describes three examples of substances moving into or out of cells.

Complete Table 4.1 by identifying the transport mechanism involved for each example.

Table 4.1

example	transport mechanism involved
uptake of magnesium ions from a lower concentration in the soil solution to a higher concentration in the cytoplasm of a root hair cell	
release of antibodies from an active B-lymphocyte (plasma cell)	
movement of sucrose from a companion cell into a phloem sieve tube element via plasmodesmata	

[3]

- (e) Enzyme inhibitors can also inhibit carrier proteins in cell surface membranes.

Explain why carrier proteins are required in cell surface membranes.

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..... [2]

- (f) Describe three roles of cell surface membranes, **other than** the transport of substances into and out of cells.

1.

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2.

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3.

..... [3]

[Total: 16]

- 4 Phosphate ions have a number of uses in organisms. These include:
- involvement in cell signalling responses
 - involvement in energy transfer processes
 - component of phospholipids
 - component of nucleotides.

Phosphatase enzymes remove phosphate groups from organic compounds, while kinase enzymes add phosphate groups.

(a) Read the following passage:

Some hormones circulating in the blood are able to trigger transcription within a cell, even though they are unable to enter the cell. Phosphatases and kinases then take part in cell activities that eventually result in genes switching on and transcription beginning.

- (i) Suggest why the hormones, referred to in the passage, are unable to enter the cell.

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..... [2]

- (ii) Use the information in the passage to outline the process of cell signalling.

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- 3 Erythropoietin, also known as EPO, is a large glycoprotein synthesised by specialised cells in the kidney. These cells are very sensitive to changes in oxygen concentration in the blood passing through the kidney and respond to a low oxygen concentration by increasing the synthesis of EPO.

EPO acts at the surface of particular target cells, such as cells in the bone marrow. These bone marrow cells are stimulated to produce red blood cells.

- (a) (i) A low oxygen concentration also leads to an increase in the quantity of mRNA in the specialised cells in the kidney.

Suggest and explain why there is this increase in the quantity of mRNA.

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.....[2]

- (ii) EPO is stored in secretory vesicles before being released from the specialised kidney cells.

Outline how EPO is released from the cells.

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.....[2]

(b) All cells of the body are exposed to circulating blood plasma containing EPO, but only particular target cells respond.

(i) Suggest and explain how EPO acts on target cells and why other cells are **not** affected.

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.....[3]

(ii) EPO cannot pass through the cell surface membrane to enter the bone marrow cells.

Suggest **one** reason why this is so.

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.....[1]

4 *Morbillivirus*, which causes measles, and the human immunodeficiency virus (HIV) share these common features:

- outer envelope surrounding the protein coat
- RNA as the genetic material
- infect cells of the immune system.

(c) The structure of *Morbillivirus* is shown in Fig. 4.1.

Haemagglutinin (H) and fusion protein (F) are glycoproteins embedded in the viral envelope.

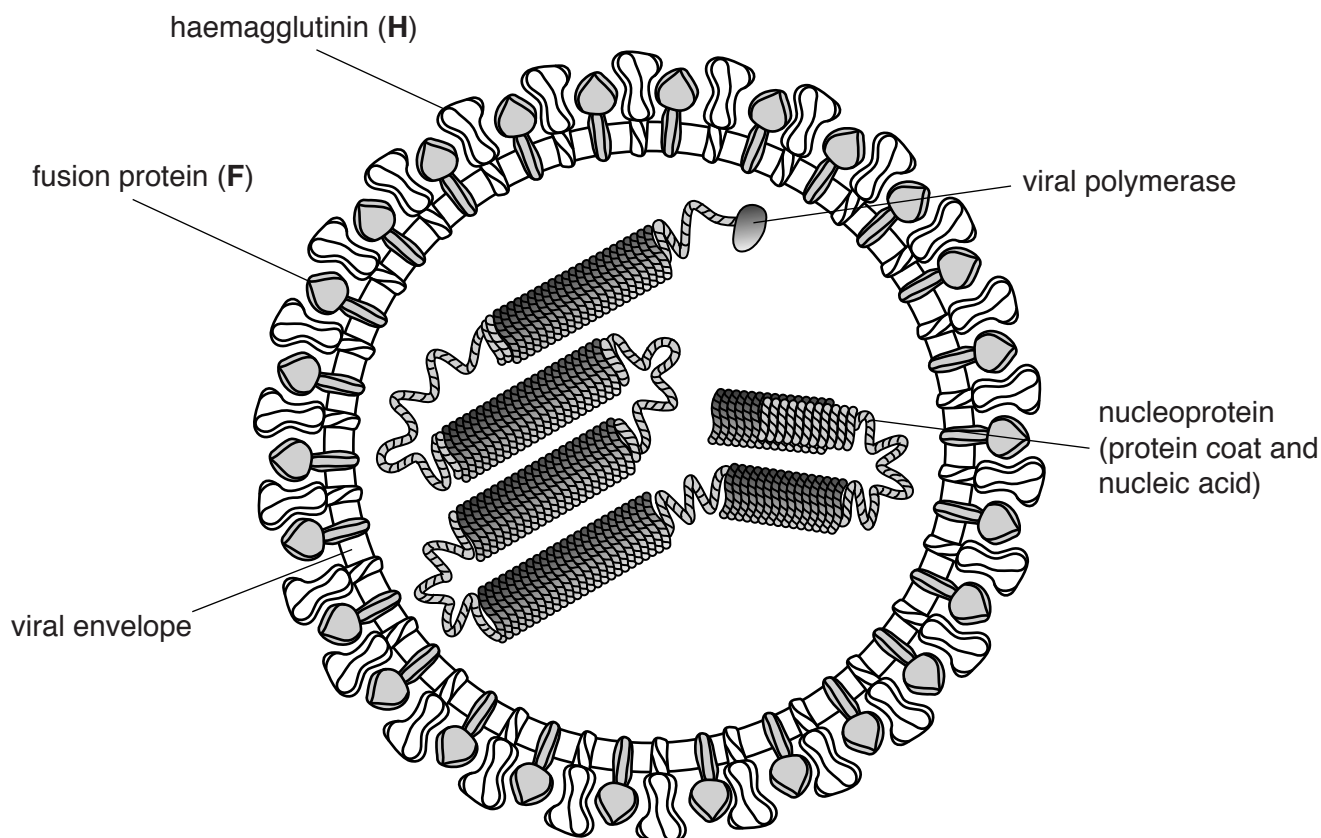


Fig. 4.1

Morbillivirus only infects cells that have a membrane glycoprotein known as signalling lymphocyte activation molecule (SLAM).

When *Morbillivirus* infects a cell, H acts before F. After the virus binds to the host cell, only the nucleoprotein with the viral polymerase enters the host cell and the virus is replicated.

New viral particles leave the host cell by budding from the cell surface membrane of the cell. This forms the main part of their envelope.

- (ii) suggest how *Morbillivirus* infects a cell with SLAM glycoproteins so that only nucleoprotein and viral polymerase enter

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.....[3]

- 6 Fig. 6.1 shows an incomplete diagram of the fluid mosaic model of membrane structure. The diagram shows the cell surface membrane of a eukaryotic cell.

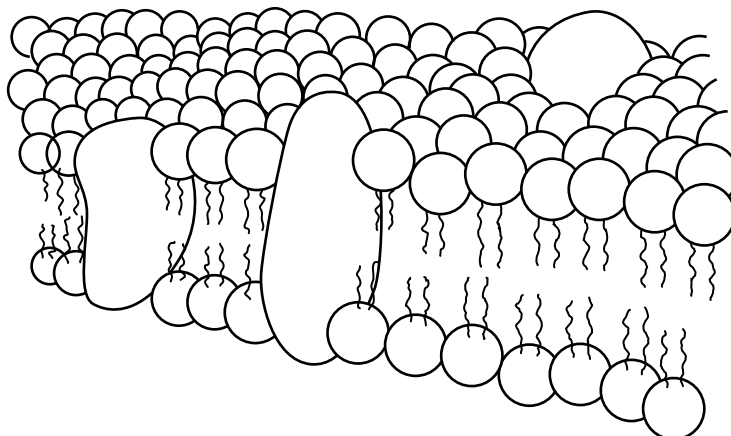


Fig. 6.1

- (a) State what is meant by the term fluid mosaic.

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.....[2]

- (b) State the thickness of a cell surface membrane.

.....[1]

- (c) List four features of cell surface membranes of eukaryotic cells that are **not** visible in Fig. 6.1.

1

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3

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4

.....[4]

[Total: 7]

- (e) As blood passes through the small intestine, small soluble products of digestion such as glucose are absorbed into the capillaries to be transported to the liver.

Fig. 4.2 is a transmission electron micrograph of intestinal epithelial cells.

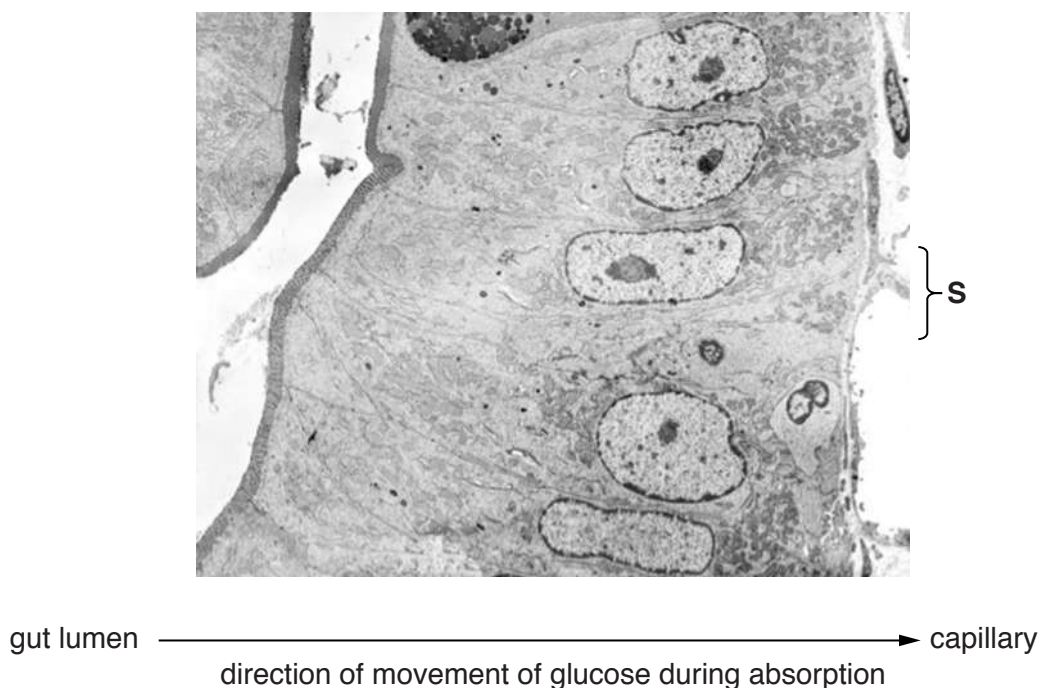


Fig 4.2

- (ii) At the surface labelled **S**, movement of glucose molecules out of the intestinal epithelial cell occurs by facilitated diffusion.

Outline the features of facilitated diffusion of glucose molecules.

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.....[3]

- 5 (c) One of the functions of a plant hormone known as cytokinin is to act as a cell signalling molecule and promote cytokinesis.

Suggest how cytokinin acts as a cell signalling molecule.

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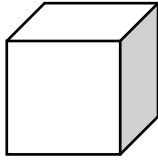
.....

.....[3]

(d) Organisms can be modelled as simple shapes for the calculation of surface area to volume ratios.

- (i) Calculate the surface area to volume ratio of an animal modelled as a cube of side length 0.1 m.

Show your working.



surface area m^2

volume m^3

surface area to volume ratio
[3]

- (ii) The surface area to volume ratio decreases as animals increase in size.

Use this fact to suggest why multicellular animals require transport systems.

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.....
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.....[2]

[Total: 11]

2 Phloem sap containing sucrose is transported in phloem sieve tubes from the source to the sink.

- (a) A student carried out an experiment using Visking tubing to investigate osmosis. The student prepared a sucrose solution to represent phloem sap at the source. This was put into Visking tubing that was tied at one end, so that the tubing was approximately 75% full.

The rest of the procedure is summarised in Fig. 2.1. The tubing was removed after 20 minutes, dried and re-weighed.

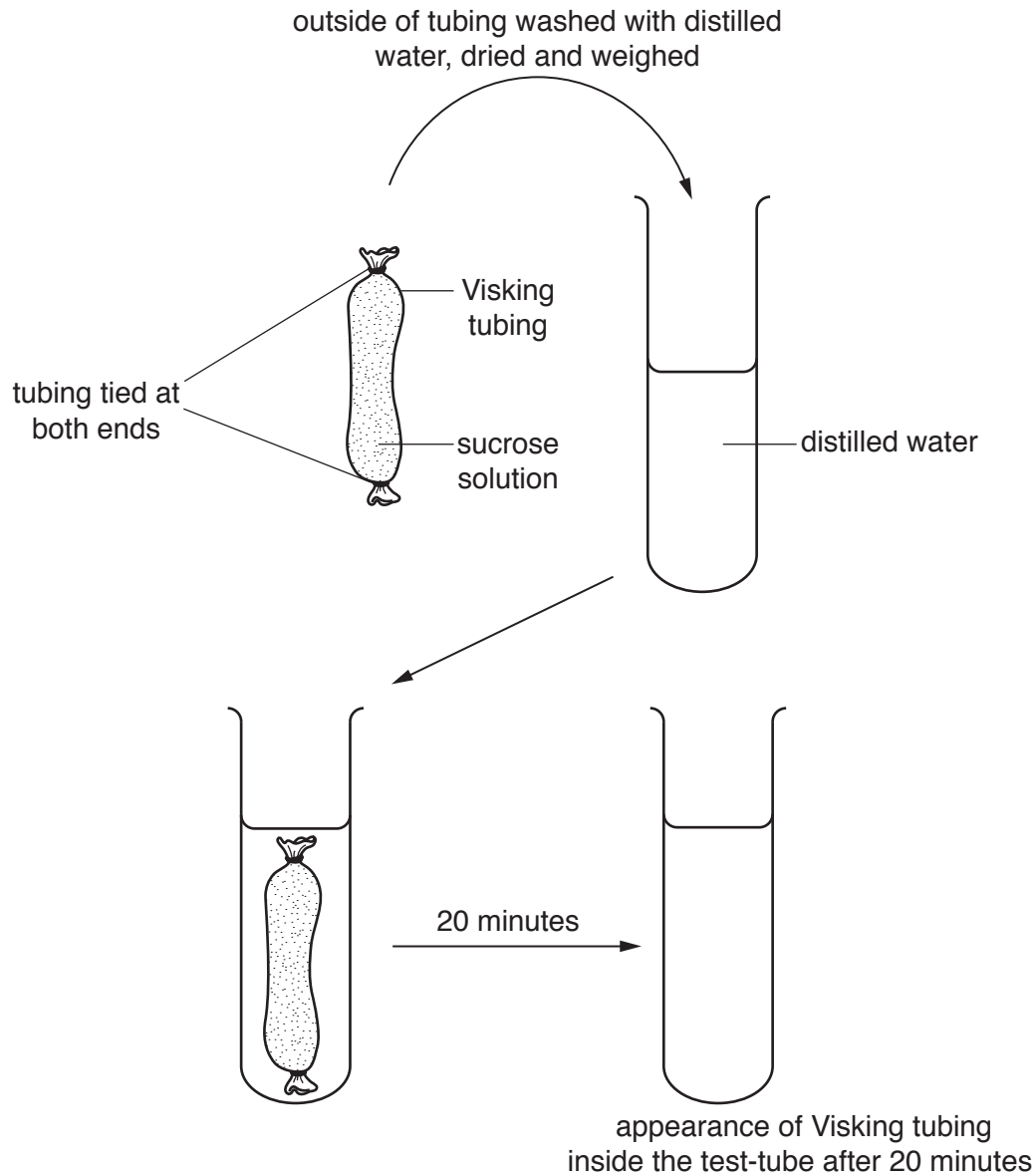


Fig. 2.1

- (i) Complete Fig. 2.1 to show the appearance of the Visking tubing inside the test-tube after 20 minutes. [1]

- (ii) State, **with reasons**, whether there would be a change in the mass of the Visking tubing containing the sucrose solution after 20 minutes.

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.....[3]

- (c) State two components of a cell surface membrane **other than** phospholipid molecules and describe their function.

component 1

function

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component 2

function

.....

.....[4]

[Total: 11]

- 2 The symptoms of cholera are caused by cholera toxin, a toxin released by the bacterium.

Cholera toxin is a protein made up of six polypeptides:

- a single copy of a polypeptide known as the A subunit that includes an extended alpha helix
- five polypeptides that together make the B subunit.

The B subunit of cholera toxin binds to a cell surface membrane component, known as GM1, of an intestinal epithelial cell. The complete cholera toxin protein then enters the cell by endocytosis. Once inside the cell, the A subunit of the protein acts as an enzyme, disrupting the normal functioning of the cell.

- (d) Outline the mechanism by which cholera toxin enters the cell.

You may use the space for annotated diagrams.

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..... [3]

6 (a) A student investigated the effect of changing the surface area to volume ratio on diffusion.

- Two different-sized blocks of agar, **X** and **Y**, were made.
- The agar contained Universal Indicator solution.
- Universal Indicator solution changes colour when acid is added.
- The blocks were placed in dilute hydrochloric acid at the same temperature.
- The student timed how long it took for each block to change colour completely.

Blocks **X** and **Y** are shown in Fig. 6.1. All dimensions are in cm.

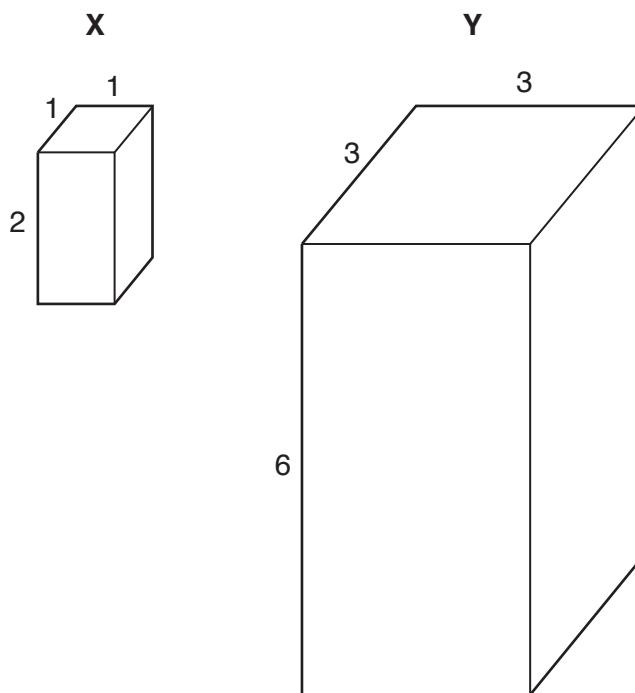


Fig. 6.1

- (i) The surface area to volume ratio of block **X** is 5:1.

Calculate the surface area to volume ratio of block **Y**.

Show your working.

[2]

- (ii) The student observed that block **X** changed colour completely in a much shorter time than block **Y**.

Explain why.

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..... [2]

- (iii) Suggest how the results of this investigation help to explain why plants need a transport system.

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..... [2]

- (b) An experiment was carried out by the student to investigate the ability of reducing sugars to diffuse through Visking tubing. Fig. 6.2 shows the apparatus used.

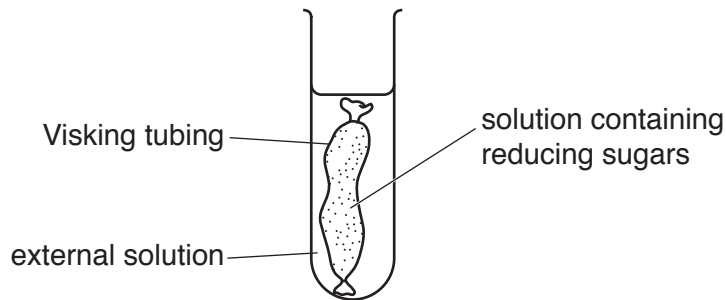


Fig. 6.2

At the start of the experiment, the external solution did not contain any reducing sugars.

At intervals, the student tested for the presence of reducing sugars, both within the Visking tubing and in the external solution.

Name the reagent that is used to test for the presence of reducing sugars.

..... [1]

[Total: 7]

5 Sugar molecules enter cells through transport proteins.

- (a) Explain why transport proteins are required for the movement of sugar molecules, such as glucose and fructose, into cells.

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.....[2]

- 5 (d) Some alveolar cells produce a surfactant that helps to prevent the collapse of alveoli on exhalation. Too much surfactant decreases the efficiency of gas exchange in the alveoli.

A glycoprotein known as GM-CSF is released by some cells of the immune system when there is too much surfactant in the alveoli. Excess surfactant is then broken down by alveolar macrophages.

Receptors for GM-CSF are on the cell surface membranes of alveolar macrophages.

Explain how maintaining the correct quantity of surfactant in the alveoli is the result of a cell signalling mechanism.

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.....[4]

- 4 (c) Some glycoproteins in cell surface membranes function as transport proteins.

State two **other** functions of glycoproteins in cell surface membranes.

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.....[2]

.....[1]

5 (d) (i) The structure of the cell surface membrane is described as a fluid mosaic.

Explain what is meant by the term *fluid mosaic*.

[2]

(ii) Outline the roles of the cell surface membrane.

.....[4]

- 3 (d) The cell has internal chemical messengers that signal when an old or damaged mitochondrion should be broken down.

Suggest **one** feature involving mitochondrial structure or function that could lead to the release of these internal signals.

.....
.....[1]

4 Fig. 4.1 is a transmission electron micrograph of the bacterium that causes cholera, *Vibrio cholerae*.

The flagellum shown in Fig. 4.1 allows movement of the bacterium within the gut and may also function to help it to bind to an intestinal epithelial cell. The organism does not enter the cell but the toxin it releases can enter and cause damage. Large quantities of water, chloride ions and sodium ions are lost from the cell.



Fig. 4.1

People with symptoms of cholera have severe watery diarrhoea and as a result can become very dehydrated.

- (a) Explain how a loss of chloride ions and sodium ions from the intestinal epithelial cell will cause a loss of water from the cell.

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.....[2]

- (b) The main treatment for cholera is oral rehydration therapy (ORT) using oral rehydration salts (ORS). This involves drinking a solution of electrolytes (mineral ions) and glucose.

Fig. 4.2 summarises the movement of glucose and sodium ions across an intestinal epithelial cell.

Fig. 4.2 includes three different types of cell surface membrane proteins:

- SGLT1 is a cotransporter protein
- GLUT2 and Na^+/K^+ pump are two types of carrier protein.

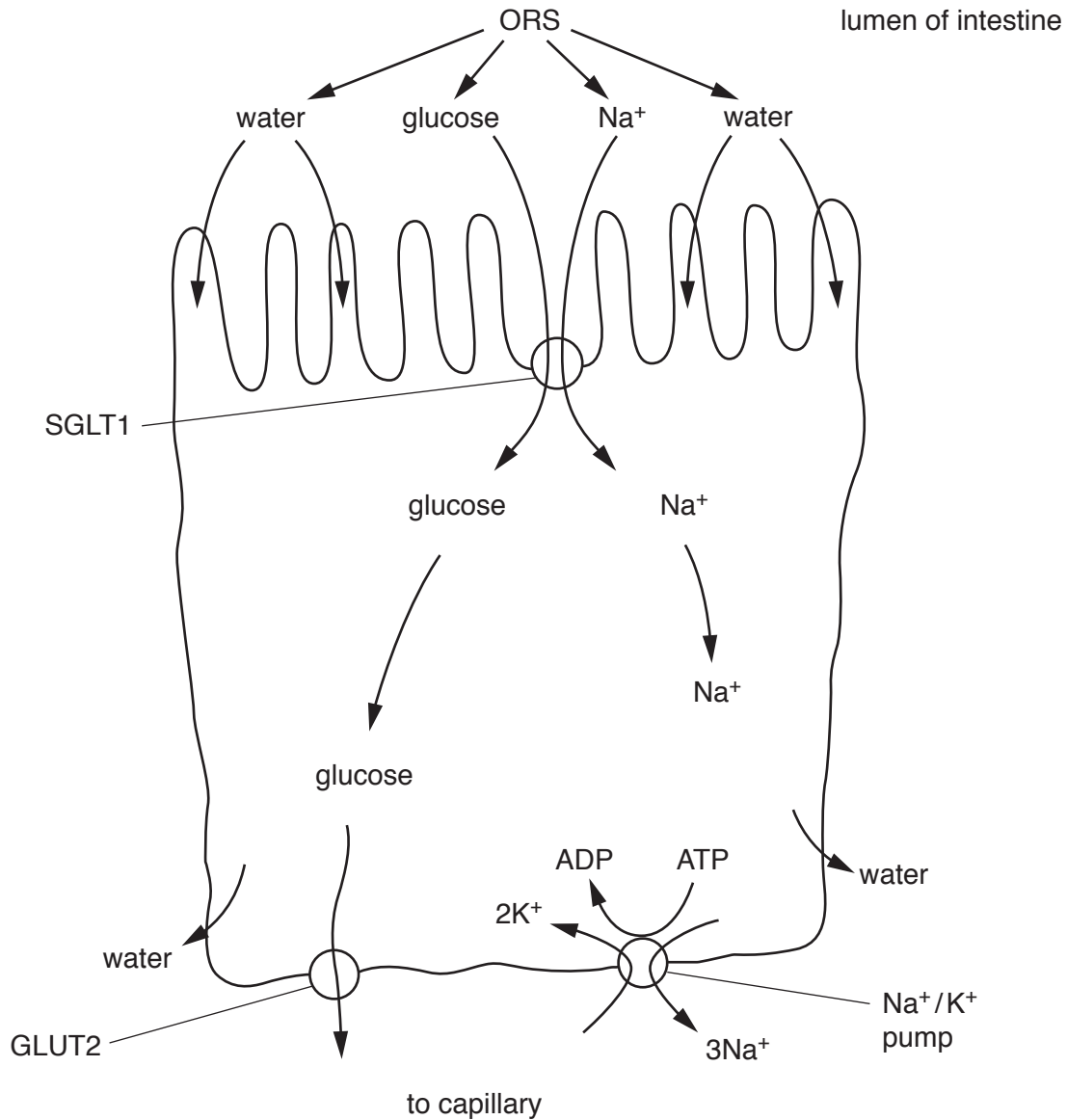


Fig. 4.2

The first rehydrating solution developed for the treatment of cholera did not contain glucose. Using ORS, patients absorb a higher concentration of sodium ions and there is an increase in water uptake.

With reference to Fig. 4.2:

- outline the transport mechanisms that result in the movement of glucose and sodium ions across the intestinal epithelial cell
- suggest how the movement of glucose and sodium ions increases water uptake by the cell.

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.....[4]

(d) The inner and outer membranes of the mitochondrion have a fluid mosaic structure similar to other cell membranes. They are both approximately 6 to 7 nanometres (nm) thick.

(i) Outline the fluid mosaic model of membrane structure.

There is space below for a diagram.

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..... [3]

(ii) The inner and outer membranes of the mitochondrion differ in the detail of their membrane components. The inner membrane is also much less permeable than the outer membrane.

Suggest **one** way in which the structure of the inner membrane may differ from that of the outer membrane to produce a **less permeable** inner membrane.

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..... [1]

[Total: 9]

- 6 (d) Ions are taken up by root hair cells using active transport and facilitated diffusion.

Describe **two** ways in which facilitated diffusion differs from active transport.

1

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2

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[2]

3 Bacteria may be classified according to differences in cell wall structure. The differences are shown by using the Gram stain.

- A Gram-positive bacterium has a cell wall mainly composed of a thick layer of peptidoglycan (murein).
- A Gram-negative bacterium has a more complex cell wall. This wall is composed of a much thinner layer of peptidoglycan and an outer layer known as the outer membrane.

Escherichia coli is a Gram-negative bacterium.

Fig. 3.1 is a diagram through the cell surface membrane **and** the cell wall of *E. coli*.

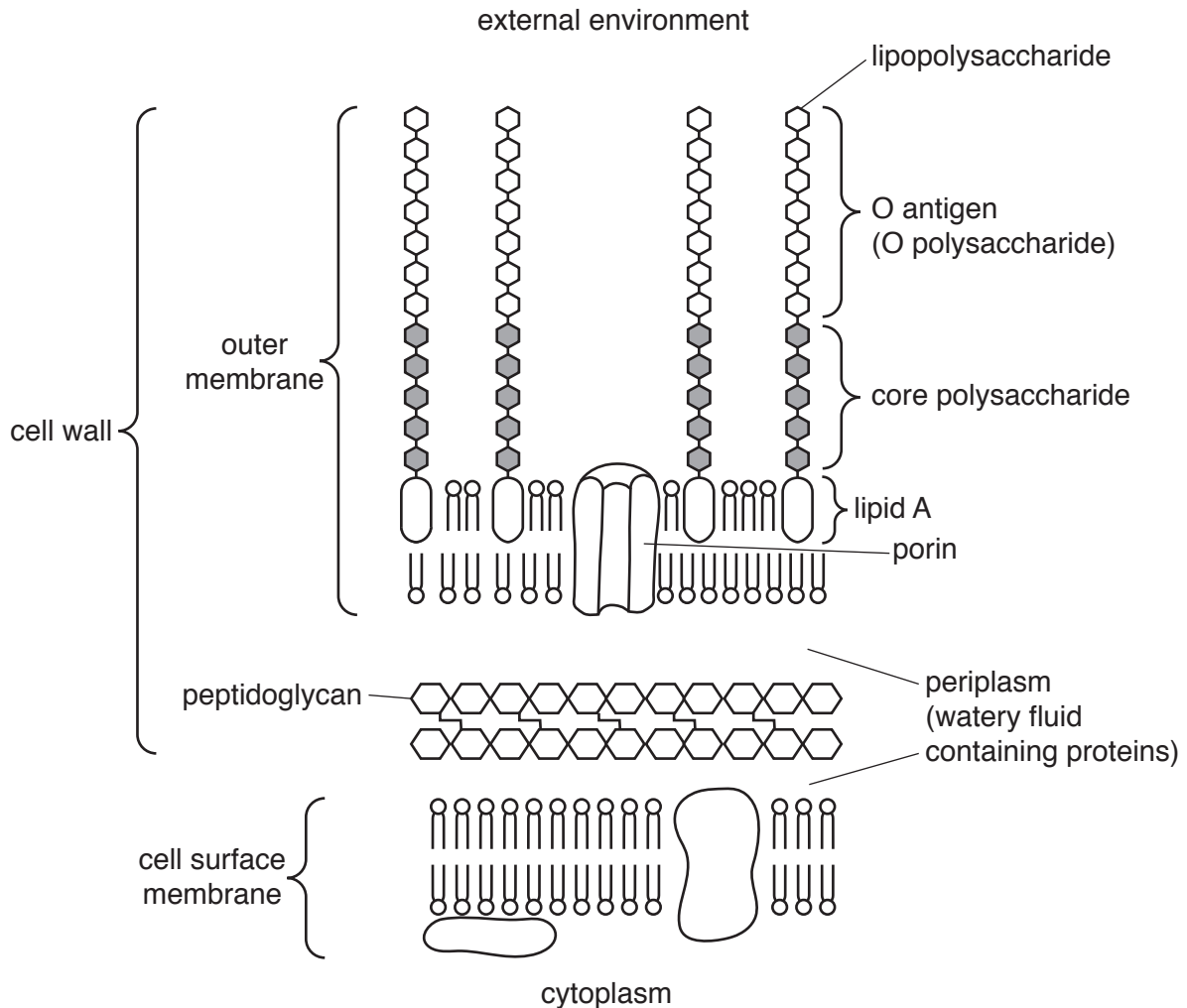


Fig. 3.1

- (b) The outer membrane contains transport proteins called OmpF porins. These porins allow the passive movement of water, ions and small, polar molecules across the outer membrane. Each OmpF porin is formed from three identical polypeptides.

(i) Explain what is meant by the term *passive*.

.....[1]

(ii) Suggest **and** explain the features of an OmpF porin as a membrane transport protein.

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.....[4]

- 2 (c) Adipocytes synthesise triglyceride lipase (ATGL), an enzyme that catalyses the formation or breakdown of triglycerides, as shown in Fig. 2.1.

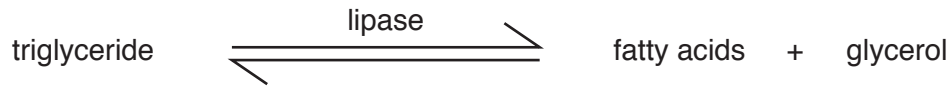


Fig. 2.1

The balance between triglyceride formation and breakdown is controlled by hormones. Fig. 2.2 is a summary of events occurring in an adipocyte when glycogen energy stores have been used up.

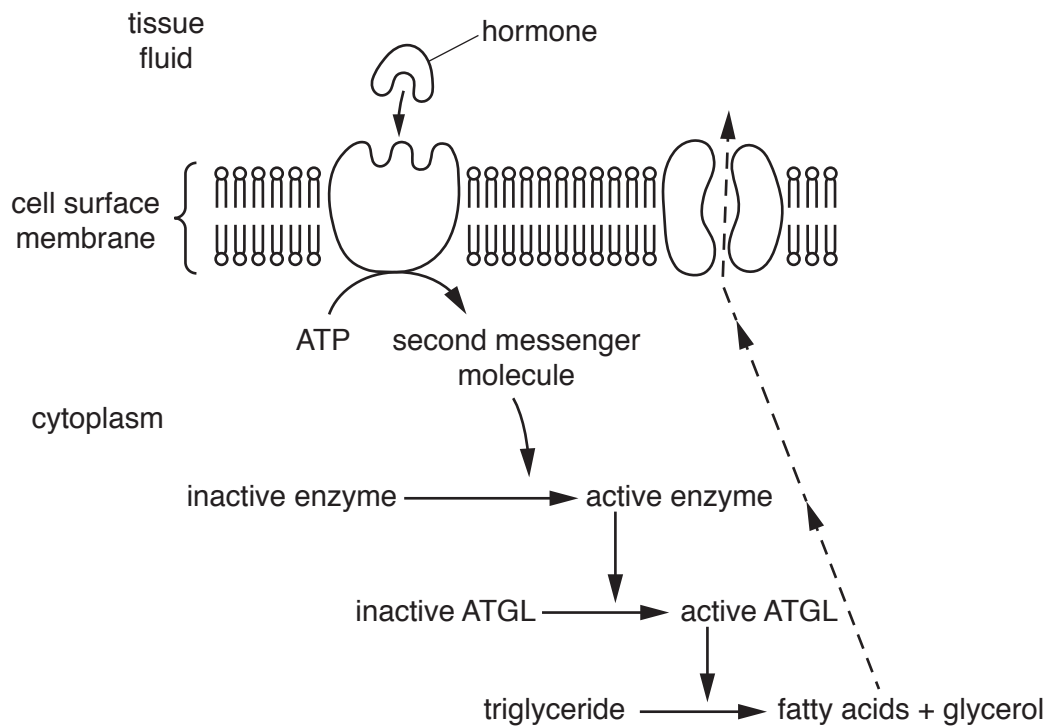


Fig. 2.2

- (ii) Name **and** outline the process by which the fatty acids shown in Fig. 2.2 exit the cell.

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.....[3]

- (iii)** Fig. 2.2 is an example of cell signalling within the body.

With reference to Fig. 2.2, outline the process of cell signalling.

[4]

- (d)** The fatty acids released from adipocytes are transported in blood plasma and are taken up by cells.

Although most cell types can metabolise fatty acids to synthesise ATP in the presence of oxygen, red blood cells **cannot** do this.

Suggest why red blood cells **cannot** metabolise fatty acids to synthesise ATP.

.....[1]

[Total: 12]

- 3 (e) (ii)** Anti-cyFBPase monoclonal antibody is added to extracts taken from the leaves of the plants with the *cyFBP* mutation.

State the expected results following addition of the monoclonal antibody that would confirm the **absence** of cyFBPase in the leaf extracts.

.....
.....[1]

- 3 (c) Following liver tissue damage, chemicals are produced and released into the circulation. These chemicals are able to stimulate the liver cells to help tissue repair.

Explain how this is an example of cell signalling.

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..... [3]

[Total: 7]

- 4 (c) The activity of the SAN is controlled by the nervous system. Noradrenaline is released by nerve cells in the SAN.

Fig. 4.1 shows the role of noradrenaline in causing calcium ions (Ca^{2+}) to enter a cell in the SAN.

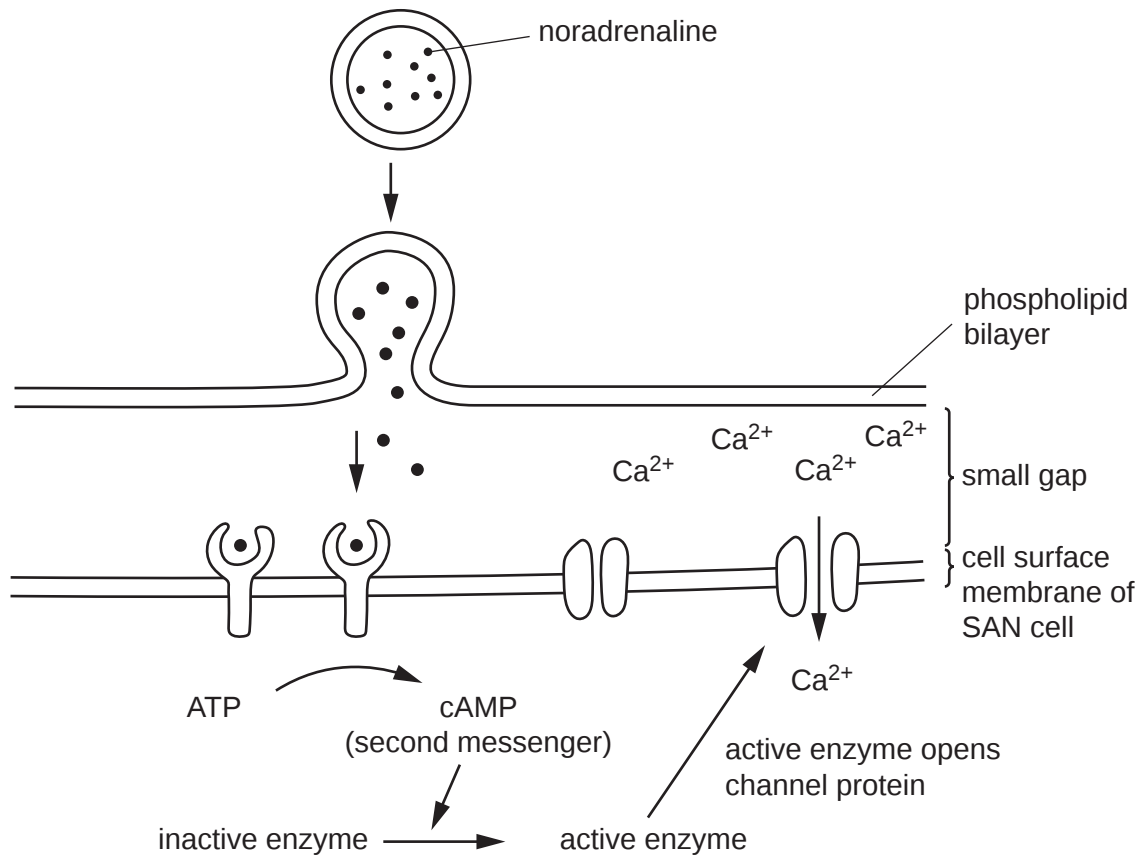


Fig. 4.1

With reference to Fig. 4.1, outline the process of cell signalling.

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..... [4]

[Total: 10]

- 5 Human prolactin (hPRL) is a globular protein. It is a single polypeptide composed of 199 amino acids. The protein is transported in the bloodstream and has an effect only on cells that have a cell surface membrane protein known as PRLR.

One effect of hPRL is to stimulate cells in the mammary glands to produce breast milk. Cells that have been stimulated by hPRL need more glucose and therefore the passive uptake of glucose increases.

- (a) State **one** reason why the cells in the mammary glands that have been stimulated by hPRL need more glucose.

.....

 [1]

- (b) An experiment was carried out to investigate the movement of glucose and hPRL across Visking tubing membrane.

- A short section of Visking tubing, tied at both ends and containing distilled water, was placed into a beaker containing a solution of glucose and hPRL.
- After 20 minutes, separate samples of the solution in the Visking tubing and the solution in the beaker were each tested for the presence of protein and reducing sugar.

A summary of the methods used, the experimental results and the deductions made are shown in Table 5.1.

Table 5.1

sample	method used	colour obtained after testing	deduction
solution in Visking tubing	biuret solution added to sample		protein absent from solution in Visking tubing
solution in beaker			protein present in solution in beaker
solution in Visking tubing	Benedict's solution added to sample and mixture heated in a water-bath		reducing sugar present in solution in Visking tubing
solution in beaker			reducing sugar present in solution in beaker

(i) Complete the column in Table 5.1 headed **colour obtained after testing**. [2]

(ii) With reference to the deductions made in Table 5.1, explain the movement of hPRL and reducing sugar across Visking tubing membrane.

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..... [2]

(c) Outline how glucose crosses the cell surface membranes of the cells of the mammary glands.

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..... [2]

- (d)** The production of milk by the cells of the mammary glands involves the action of several different enzymes. The cell surface membranes of these cells contain the membrane protein PRLR.

Fig. 5.1 shows an outline summary of hPRL involvement in the production of breast milk.

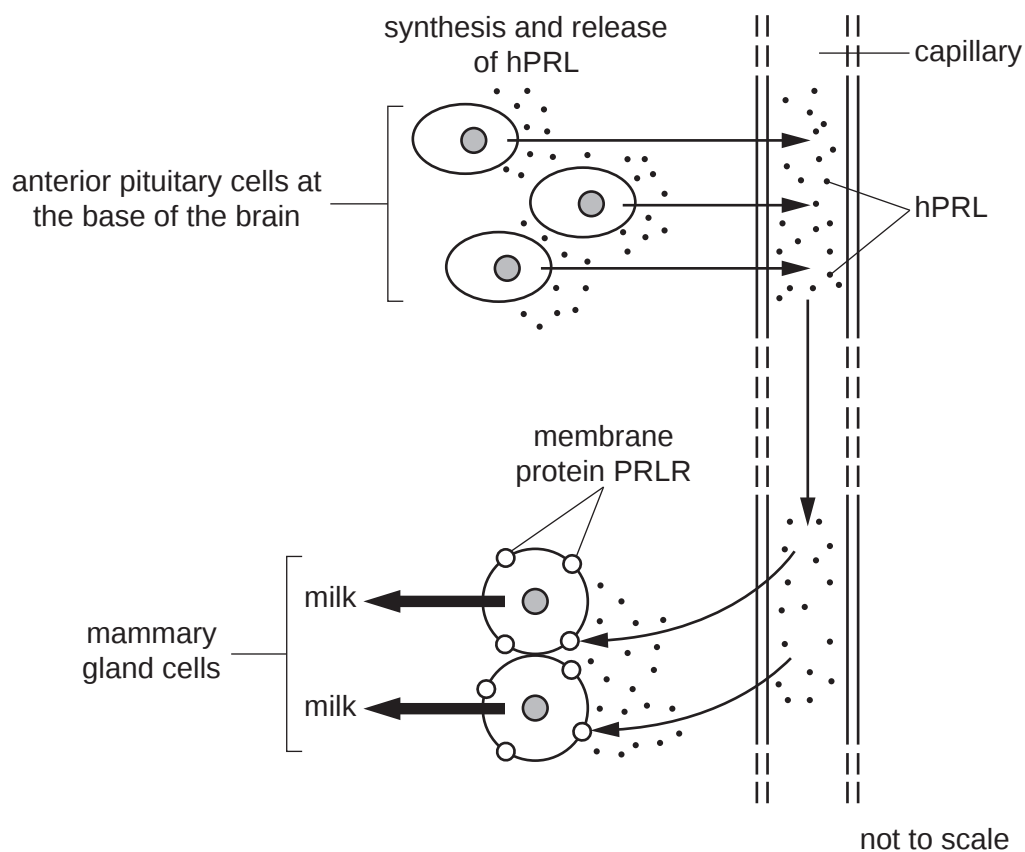


Fig. 5.1

Explain why the production of breast milk can be described as an example of a cell signalling process.

..... [4]

[Total: 11]

3 A student carried out an experiment to investigate the effect of increasing the concentration of sucrose solution on the mass of potato tissue.

- Potato tissue was cut into cylinders of equal length and diameter.
- The mass of each cylinder was recorded.
- Each cylinder was put into a solution of sucrose, as shown in Fig. 3.1.

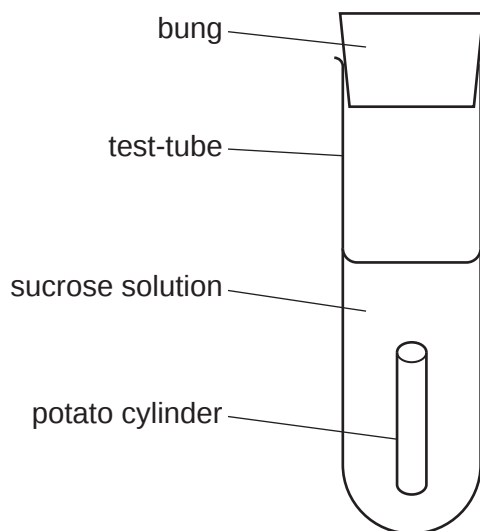


Fig. 3.1

- After one hour each cylinder was removed, blotted dry and reweighed.
- The percentage change in mass of each cylinder was calculated.
- The experiment was repeated three times.
- The mean percentage change in mass of the potato cylinders in each sucrose solution was calculated.

Fig. 3.2 shows the results of this investigation.

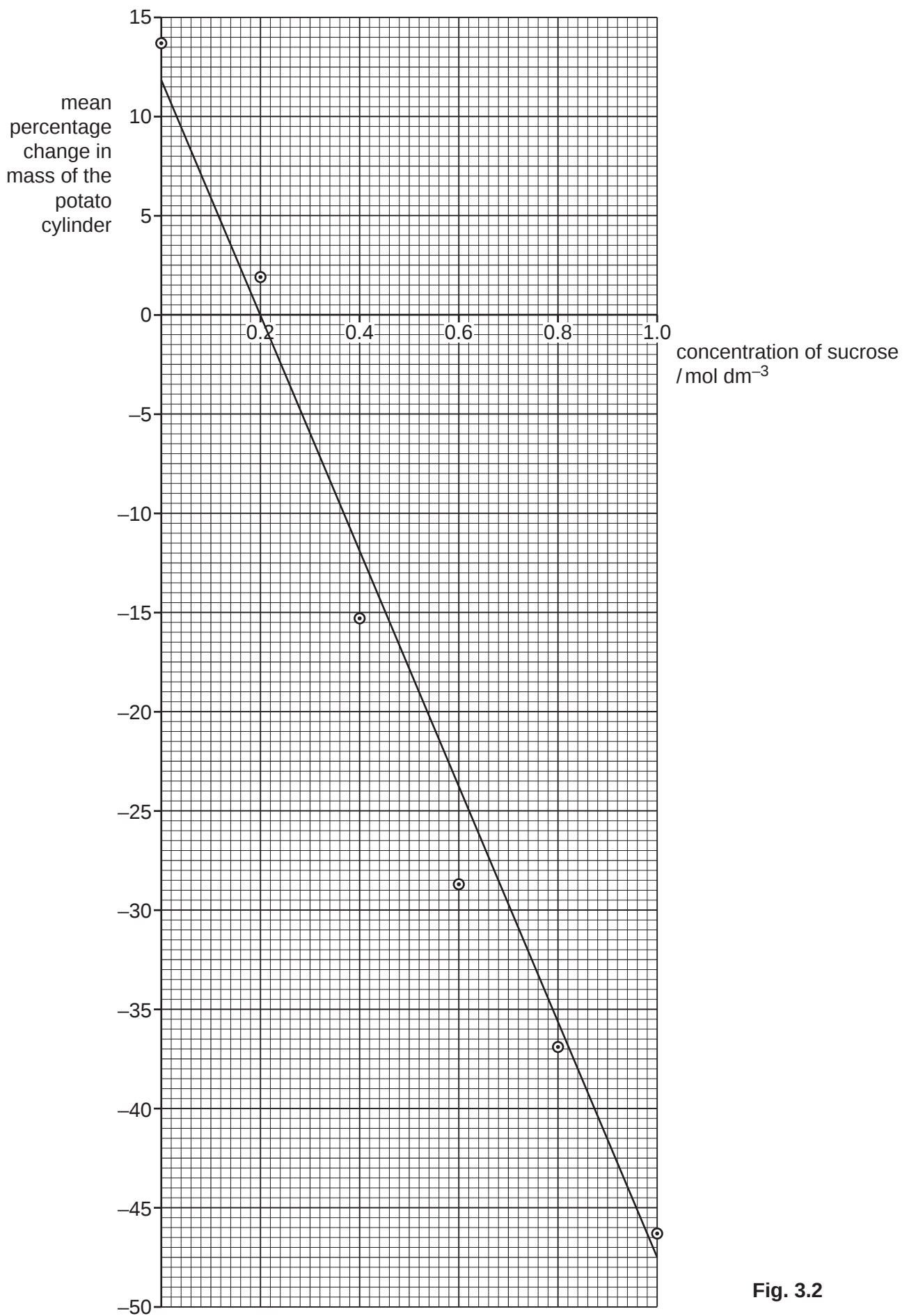


Fig. 3.2

- (a) With reference to Fig. 3.2, describe the effect of increasing the concentration of sucrose solution on the mass of the potato cylinders.

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..... [3]

- (b) Explain why there was a change in mass for the potato cylinders in 0.6 mol dm^{-3} sucrose solution.

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..... [3]

[Total: 6]

- 6 Fig. 6.1 is a diagram of the cell surface membrane of a squamous epithelial cell lining an alveolus.

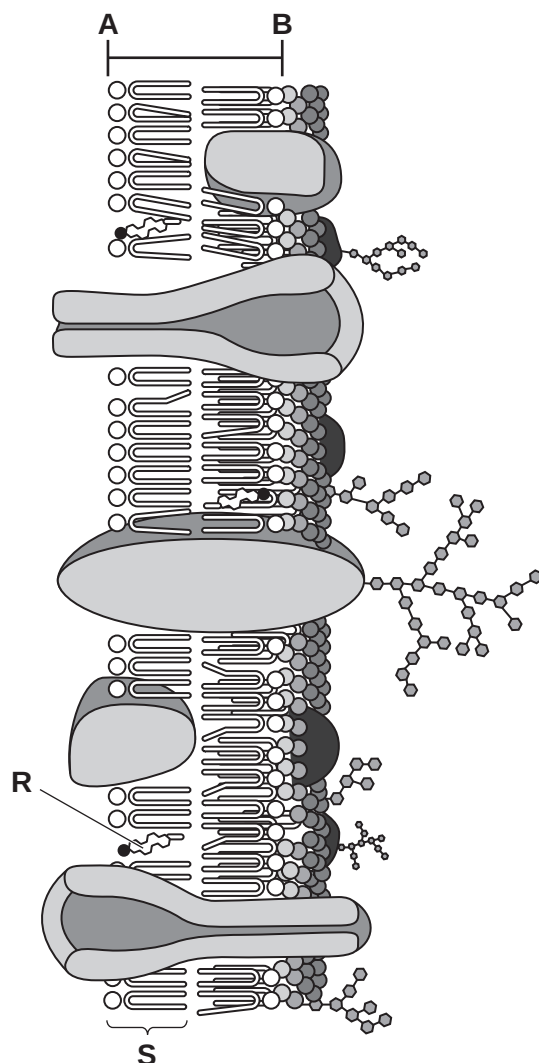


Fig. 6.1

- (a) (i) A student measured the line **A–B** and calculated the actual width of the membrane in Fig. 6.1.

State the unit that the student should use for the actual width of the membrane.

..... [1]

- (ii) With reference to Fig. 6.1, state how to identify the external surface of the cell surface membrane.

.....

..... [1]

(b) Name **R** and **S** in Fig. 6.1 **and** describe their roles in the membrane.

component R

name

role

.....

component S

name

role

.....

[4]

[Total: 6]

9700/22/F/M/20

2(c)(ii) Explain why phospholipids are able to form a bilayer in cell membranes.

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..... [2]

9700/22/F/M/20

7(c) The cell sap in the vacuole of the cell shown in Fig. 6.1 has a pH of 5.0. The cytosol has a pH of 7.2.

The tonoplast controls the passage of hydrogen ions from the cytosol into the vacuole. The low pH created by the entry of hydrogen ions is optimum for the action of acid hydrolase enzymes in the vacuole. Acid hydrolase enzymes are also found in lysosomes in animal cells.

- (i)** Suggest which transport mechanism is used to move hydrogen ions from the cytosol of the parenchyma cell into the vacuole.

Explain your choice.

transport mechanism

explanation

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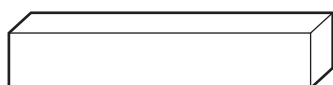
.....

..... [3]

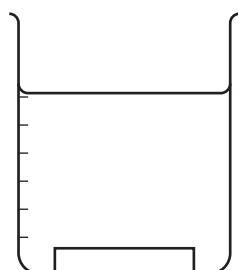
- 6 A student carried out an investigation to estimate the water potential of potato tissue. The main steps in the procedure and in the analysis of results are outlined in Fig. 6.1.

beaker	concentration of sucrose solution / mol dm ⁻³
1	0.0
2	0.1
3	0.2
4	0.3
5	0.4
6	0.5

Six different concentrations of sucrose solution were prepared and an equal volume of each was placed in a labelled beaker.



Six equal-sized blocks of potato tissue were cut out of the same potato, blotted dry and weighed.



One potato block was immersed in the solution in each beaker for 30 minutes.

After this time, the block was removed, blotted dry and reweighed.



The experiment was repeated twice.



The mean percentage change in mass of potato tissue was calculated for each concentration of sucrose used.



A graph was drawn of mean percentage change in the mass of potato tissue against concentration of sucrose.

Fig. 6.1

- (a)** Explain why the different concentrations of sucrose result in different mean percentage changes in mass of potato tissue.

[3]

- (b)** State how the graph is used to estimate the water potential of the potato tissue.

..... [1]

[Total: 4]

5(b) Fig. 5.2 is a photograph of two African elephants, *Loxodonta africana*.



Fig. 5.2

- (i) Describe the difference in surface area to volume ratio between the adult elephant and baby elephant shown in Fig. 5.2.

.....
..... [1]

3(c) Testosterone molecules and cytokine molecules are transported in the circulatory system to reach their target cells. Testosterone molecules are able to enter their target cells and bind to receptors within the cytoplasm.

(i) Outline **one** way in which testosterone molecules could enter their target cells.

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..... [2]

(ii) Cytokine molecules are not able to enter their target cells.

Suggest **and** explain why cytokine molecules are **not** able to cross the cell surface membrane to enter their target cells.

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..... [2]

3 Visking tubing can be used to investigate the properties of cell membranes.

A student carried out an experiment to investigate osmosis using Visking tubing. An outline of the investigation is shown in Fig. 3.1.

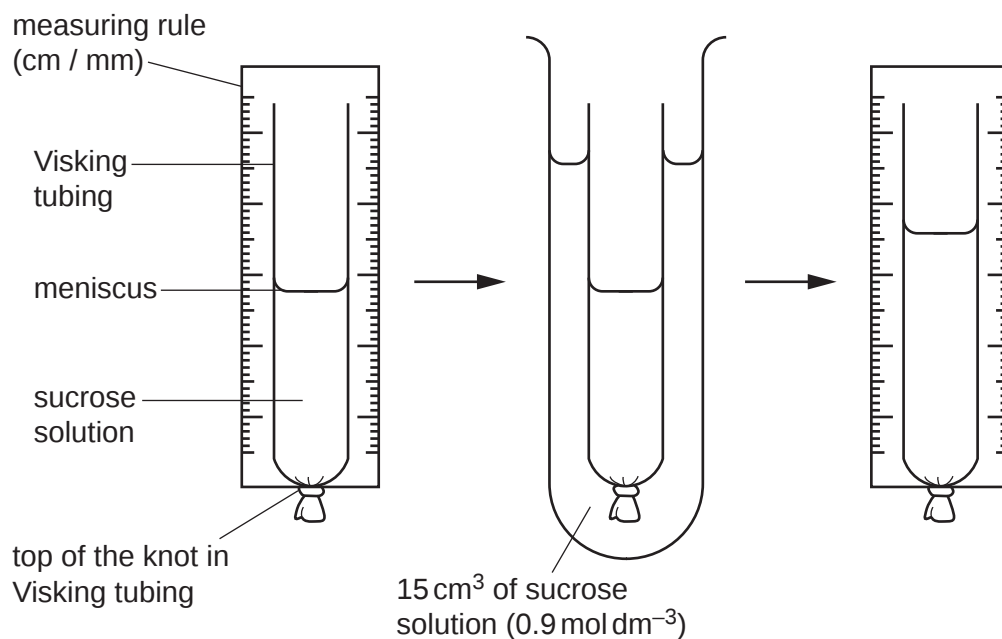


Fig. 3.1

- Six pieces of Visking tubing were filled with 10 cm^3 of different concentrations of sucrose solution: 0.0, 0.4, 0.8, 1.2, 1.6 and 2.0 mol dm^{-3} .
- The height of the meniscus of each solution in the Visking tubing was measured.
- The pieces of Visking tubing were put into test-tubes containing 15 cm^3 of 0.9 mol dm^{-3} sucrose solution.
- After 20 minutes, the pieces of Visking tubing were removed from the test-tubes and the height of the meniscus in each was measured.

The results are shown in Table 3.1.

Table 3.1

concentration of sucrose solution inside Visking tubing / mol dm^{-3}	difference in height of meniscus after 20 minutes / mm
0.0	-12
0.4	-4
0.8	-2
1.2	+1
1.6	+6
2.0	+11

- (a) The Visking tubing used by the student was **not** permeable to sucrose.

Explain the results shown in Table 3.1.

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..... [3]

(b) When red blood cells are placed in water they are destroyed by bursting.

The student also investigated how red blood cells are affected by immersion in solutions of sodium chloride of different concentration. Blood samples of the same volume were added to solutions of sodium chloride in separate test-tubes.

After 10 minutes, the student took 0.1cm^3 of the blood samples from the test-tubes and estimated the percentage of red blood cells that had burst in each blood sample.

Fig. 3.2 shows the student's results.

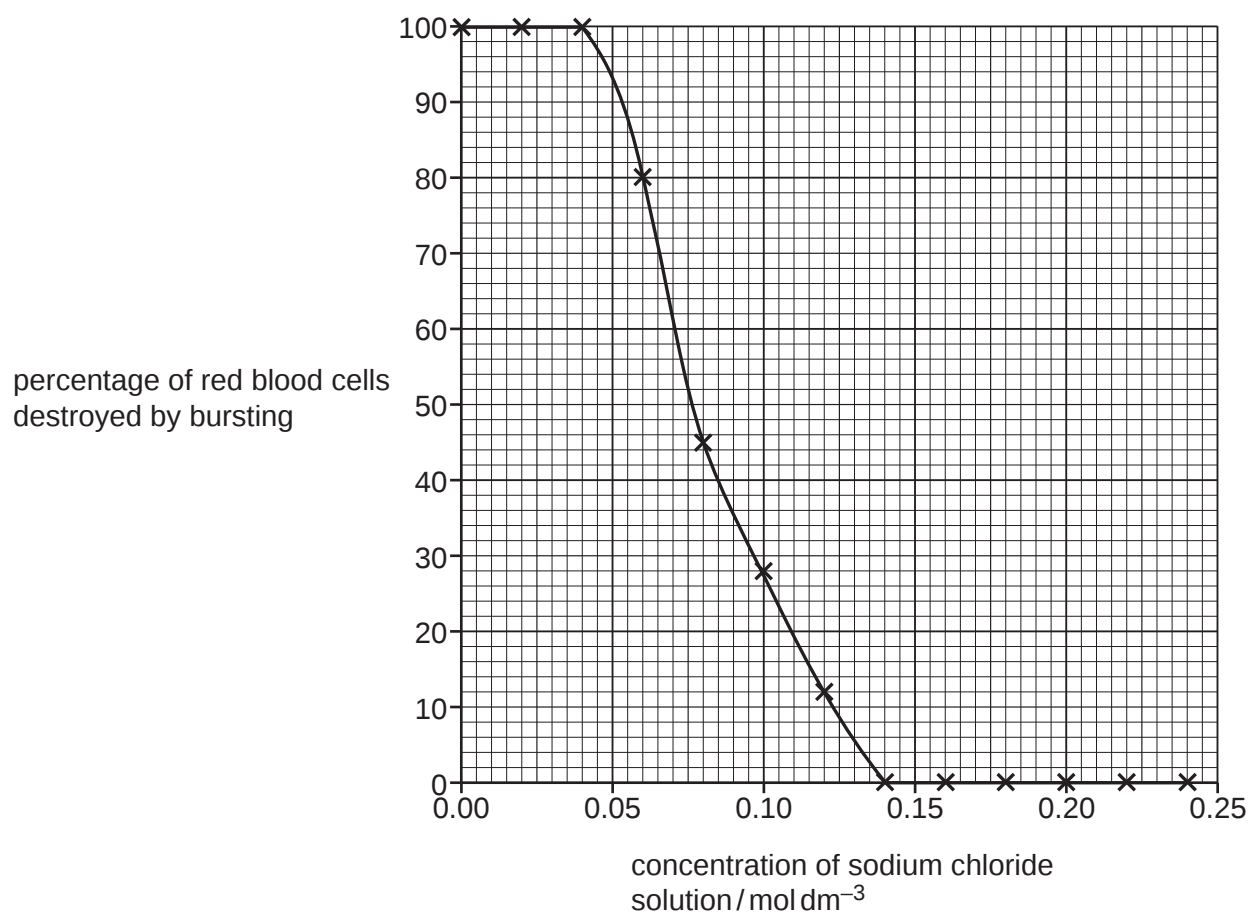


Fig. 3.2

Describe **and** explain the effects on red blood cells of immersion in different concentrations of sodium chloride as shown in Fig. 3.2.

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..... [4]

[Total: 7]

6(e) Carrier proteins in the membranes of lysosomes maintain a lower pH than the surrounding cytoplasm by moving hydrogen ions.

Suggest how the carrier proteins maintain the lower pH within the lysosomes.

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..... [2]

3. Hormone **S** is a steroid hormone involved in cell signalling.

Fig. 3.2 shows the sequence of events that occurs when hormone **S** enters a target cell.

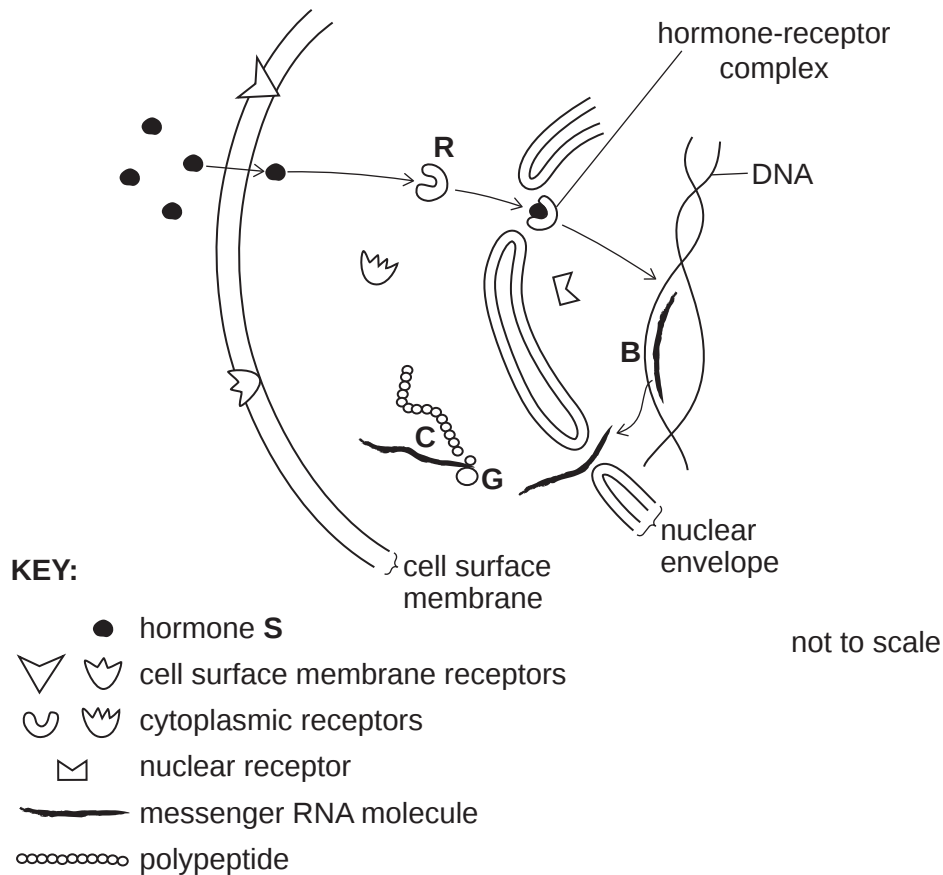


Fig. 3.2

(b) Explain why hormone **S**, shown in Fig. 3.2, does not need to pass through a transport protein to enter the cytoplasm of the target cell.

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..... [2]

(c) The target cell can respond to other cell signalling molecules in addition to hormone **S**. The cell has receptors in the cell surface membrane, in the cytoplasm and in the nucleus.

Explain why hormone **S** binds only with receptor **R** in the cytoplasm and **not** with the other receptors shown in Fig. 3.2.

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.....

..... [1]

(d) The hormone-receptor complex shown in Fig. 3.2 enters the nucleus and binds to DNA. This switches on a gene coding for a polypeptide that is synthesised in the cytoplasm.

(i) Name the structure through which the hormone-receptor complex enters the nucleus.

..... [1]

(ii) Name the processes occurring at **B** and **C**.

B

C [2]

(iii) Name structure **G**.

..... [1]

4(b) A student investigated the effect of SA:V on diffusion.

Agar was prepared with Universal Indicator solution and sodium hydroxide solution. The agar was coloured blue.

Three cubes, **A**, **B**, and **C**, were cut from a solid block of blue agar. Each cube was a different size.

Universal Indicator solution changes to a red colour in the presence of acid.

The student prepared Table 4.1 to show the sizes and SA:V of each cube.

Table 4.1

cube	length of each side / cm	total surface area / cm ²	volume /	SA:V
A	1	6	1	6:1
B	2	24	8	3:1
C	3			2:1

Complete Table 4.1 by:

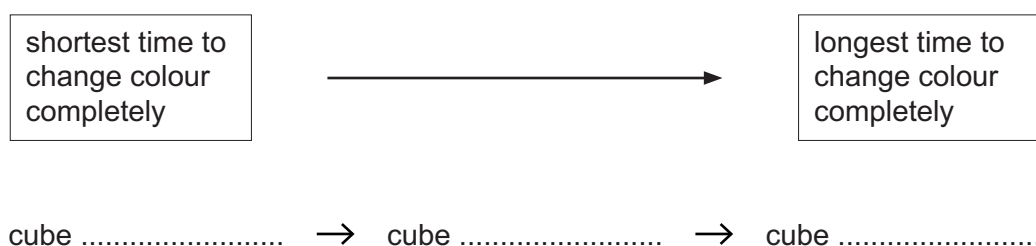
- writing the correct units for volume
- calculating the total surface area, and volume, of cube **C**.

[2]

(c) Cubes **A**, **B** and **C** were placed in a small beaker. At time 0 seconds, dilute hydrochloric acid was added to the beaker to cover the cubes.

The student timed how long it took for each cube to change colour completely.

Complete Fig. 4.1 to show the results that were obtained.



[1]

Fig. 4.1

- (d) Some people with emphysema may be offered lung volume reduction surgery (LVRS), in which diseased lung tissue is surgically removed.

One expected outcome of the surgery is an improvement in total lung surface area to volume ratio (total lung SA:V).

Suggest why there is an improvement in total lung SA:V after the surgery has been carried out.

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..... [2]

- (c) One function of a Golgi body is to package molecules into Golgi vesicles.

- (iii) Some Golgi vesicles contain glycoproteins or glycolipids to be added to the cell surface membrane.

Outline the role of **glycolipids** in the cell surface membrane.

.....

..... [1]

- 2(b) (i) The cell surface membranes of the respiring cells have a role in regulating the exchange of substances between the cells of the body and the blood.

Draw a diagram in the space below to show the arrangement of phospholipid molecules in the cell surface membrane.

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..... [2]

(ii) Cholesterol is a molecule found in the cell surface membrane.

Describe **one** role of cholesterol in the cell surface membrane.

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..... [1]

- 1** There are two types of cell, prokaryotic and eukaryotic. Bacterial cells are prokaryotic and plant cells are eukaryotic.
- (b)** One role of the cell surface membrane of bacterial cells and plant cells is the transport of substances into and out of cells.

Explain how membrane carrier proteins and membrane channel proteins are involved in the transport of substances into and out of cells.

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..... [3]

4(b) The width of stomatal openings in *A. thaliana* is regulated by movement of ions. These ions move through channel proteins in the cell surface membranes of the guard cells.

- (i) Draw a diagram to show part of a cell surface membrane with a channel protein.

Label your diagram.

[3]

- (ii) Explain why channel proteins are needed for the movement of ions into and out of cells.

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..... [2]

- (c) The outward movement of ions from guard cells causes stomata to close.

A variety of *A. thaliana* does **not** have channel proteins for the outward movement of ions in the cell surface membranes of the guard cells.

Suggest **and** explain the effect of **not** having these channel proteins on transpiration.

LINKS WITH TOPIC 7

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..... [3]

- 1 (a) Table 1.1 shows three of the processes by which substances in solution can move across cell membranes. It also lists five statements that may apply to each of these three processes.

Complete Table 1.1 to show which of the statements apply to each of the three processes shown.

Use a tick (✓) to show that the statement applies or a cross (X) to show that the statement does not apply.

Each box must contain a tick or a cross.

The first row has been completed for you.

Table 1.1

statement	process		
	active transport	facilitated diffusion	simple diffusion
movement of oxygen into a red blood cell	X	X	✓
occurs in both animal and plant cells			
uses carrier proteins			
movement of non-polar molecules between the fatty acid tails of the phospholipid molecules			
movement of ions down a concentration gradient			

[4]

1(c) One role of an intestinal epithelial cell is the absorption of glucose from the gut lumen into the circulatory system. This involves different membrane transport proteins.

The events occurring in an intestinal epithelial cell during the absorption of glucose are summarised in Fig. 1.2.

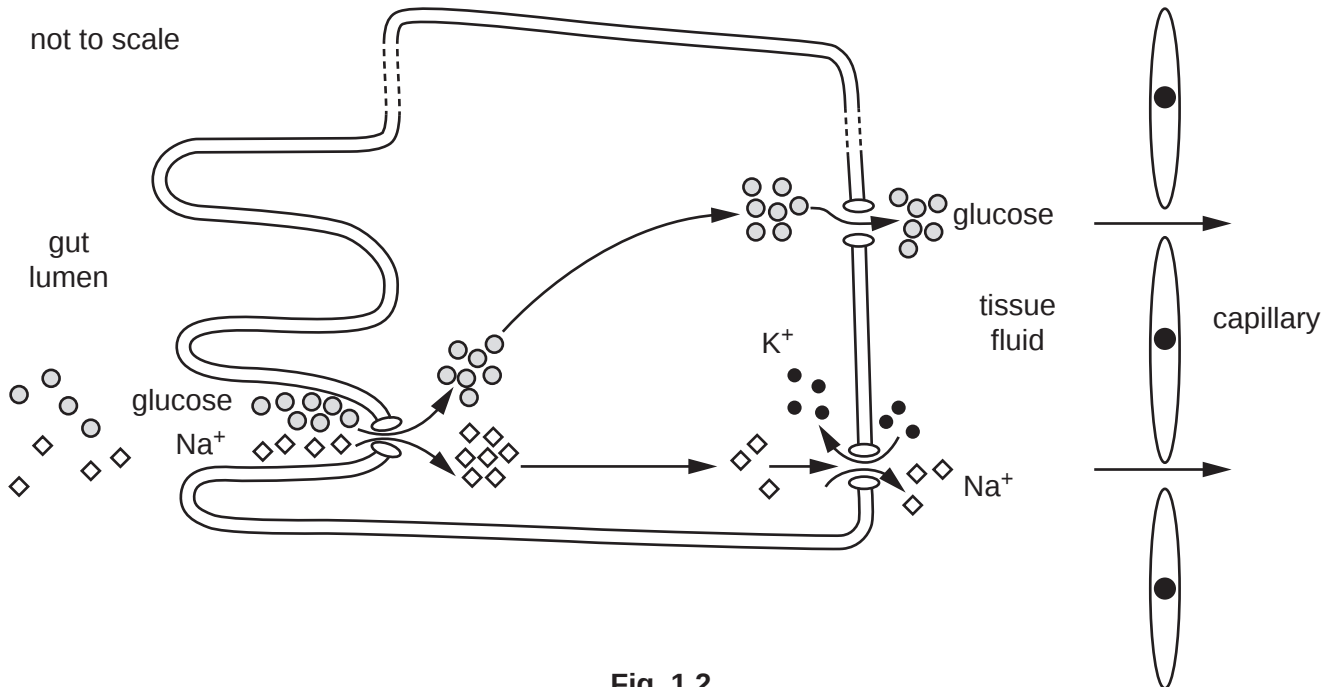


Fig. 1.2

- Sodium ions (Na^+) are removed from the cell by active transport through a transport protein known as a sodium-potassium (Na^+/K^+) pump.
 - This decreases the concentration of Na^+ in the cell compared to the gut lumen.
 - Glucose molecules are cotransported with Na^+ into the cell from the gut lumen.
 - Glucose molecules are transported out of the cell into the tissue fluid down a concentration gradient.
- (i)** Active transport involves water-soluble substances, such as Na^+ and K^+ , and the use of ATP to provide the energy needed for their transport through carrier proteins.

Outline **other** features of active transport.

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[2]

- (ii) Glucose molecules enter the cell through a membrane protein.

Suggest why glucose molecules need to be cotransported with Na^+ when it enters the cell through the membrane protein.

LINKS WITH TOPIC 7

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..... [2]

- (iii) Explain how microvilli increase the uptake of glucose into an intestinal epithelial cell.

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..... [2]

- (d) Stem cells are also located in the wall of the small intestine. These cells divide by mitosis continuously.

Suggest **and** explain the importance of mitosis by stem cells in the small intestine.

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..... [4]

- 2 (b) Protoplasts are plant cells that have had their cell walls removed by treatment with enzymes. Scientists often use protoplasts when researching ways to improve the yield of crop plants.

Fig. 2.1 is a scanning electron micrograph of protoplasts of cells from the tobacco plant, *Nicotiana tabacum*.

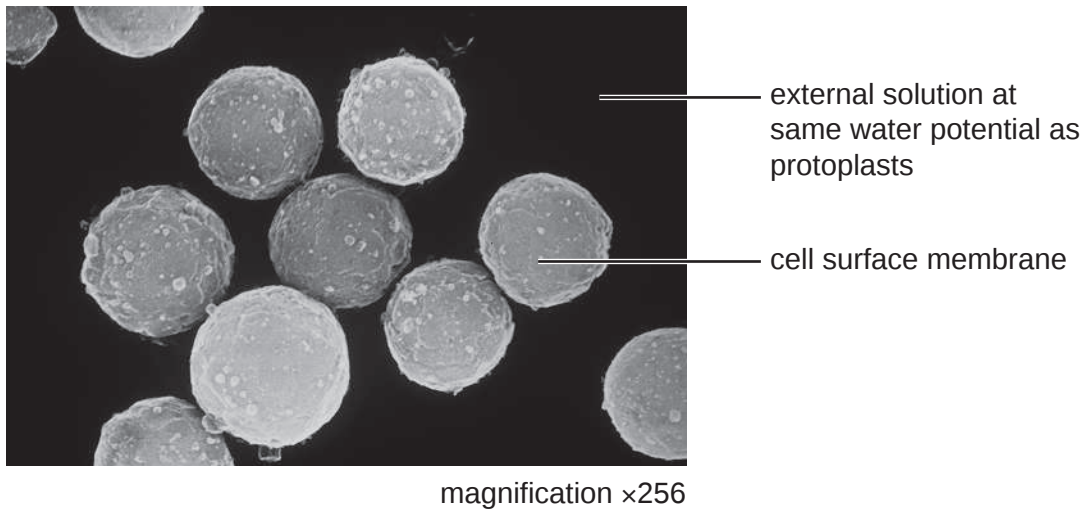


Fig. 2.1

Explain why scientists keep the protoplasts in a solution that has the same water potential as the cell.

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..... [2]

(d) Fig. 5.3 shows the molecular structure of arachidonic acid. Not all hydrogen atoms are shown.

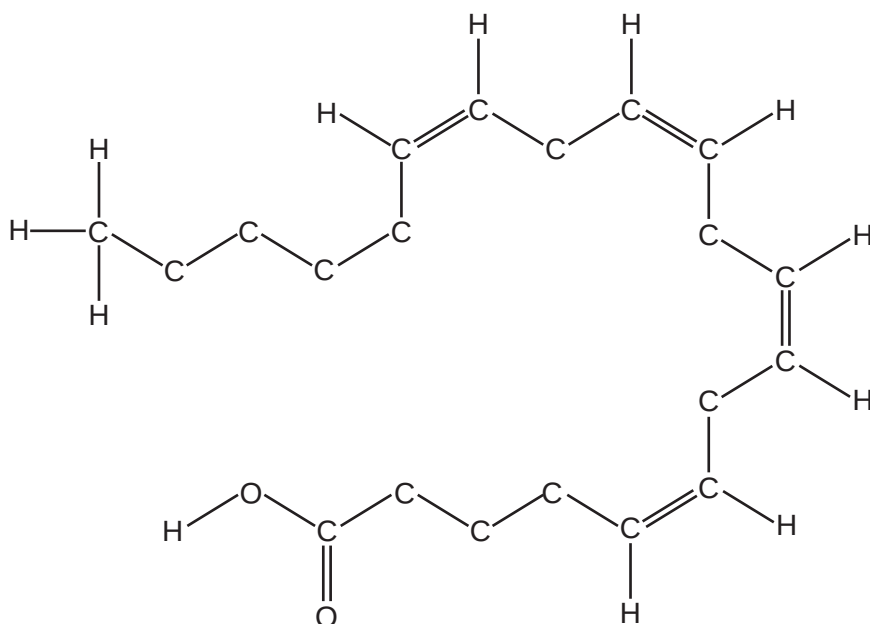


Fig. 5.3

With reference to Fig. 5.3, explain why increasing the proportion of phospholipids with arachidonic acid in a cell will increase the fluidity of the cell surface membrane of the cell.

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..... [3]

- 5 Cathelicidin LL-37 is a cell signalling compound that stimulates many different cells in humans. One role of cathelicidin LL-37 is stimulating the production of endothelial cells in the formation of capillaries during wound healing.

(a) (i) Explain how it is possible for many different cell types to respond to the same cell signalling compound.

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..... [2]

- 2 (a) Cysteine is an amino acid containing sulfur. Fig. 2.1 shows the structure of the molecule formed by joining two cysteine molecules together.

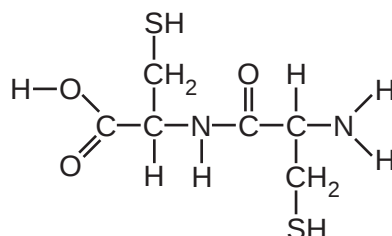


Fig. 2.1

Goblet cells in the human gas exchange system produce proteins called mucins.

The ends of mucin molecules contain many cysteine residues. Mucin strands are formed by joining the ends of mucin molecules together through covalent bonds between R-groups.

- (ii) Mucin strands are transported out of the goblet cells and then absorb water to form mucus.

Suggest **and** explain how mucin strands are transported out of the goblet cells.

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..... [3]

3 Fig. 3.1 shows some fruits (grapes) of the grapevine, *Vitis vinifera*.



Fig. 3.1

Sucrose is transported in the phloem of the grapevine to the fruits. In the fruits, sucrose is hydrolysed by the enzyme sucrase, which is found in cell walls. The glucose and fructose produced by the hydrolysis of sucrose pass through membrane proteins, known as hexose transporters, into the cytoplasm of the fruit cells.

- (a) State why membrane proteins are required for the movement of molecules, such as glucose, across cell surface membranes into cells.

.....
.....
..... [1]

Researchers investigated one type of hexose transporter, known as VvHT1, which is found in the fruit cells of *V. vinifera*. They used a mutant strain of yeast that has very few hexose transporters in its cell surface membranes to investigate the properties of VvHT1. The researchers inserted molecules of VvHT1 into the cell surface membranes of the mutant strain of yeast.

- Equal volumes of mutant yeast cells with VvHT1 were kept in eight different concentrations of glucose solution.
- The rate of uptake of glucose by the yeast cells in each solution was determined.
- All the solutions were kept at the same temperature and pH.

The results are shown in Fig. 3.2.

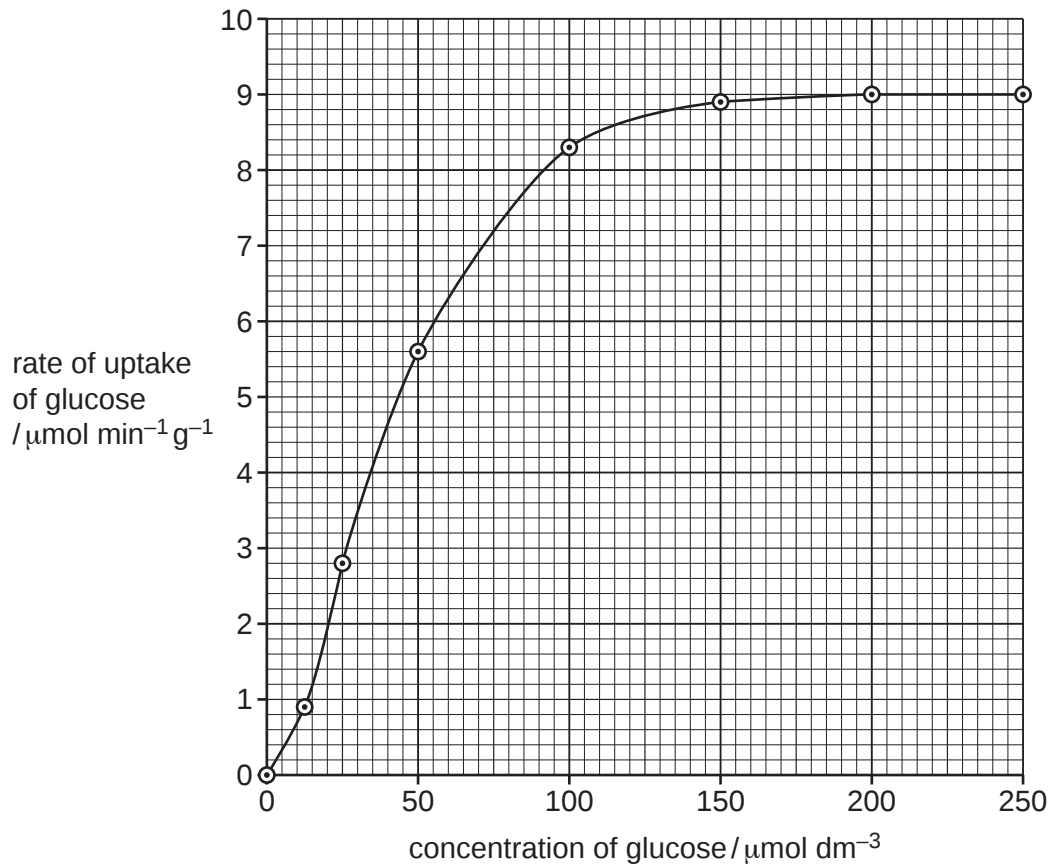


Fig. 3.2

- (b) (i) The researchers concluded that VvHT1 is responsible for the facilitated diffusion of glucose into the cells.

Explain how the results in Fig. 3.2 provide evidence to support this conclusion.

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..... [2]

- (ii) The researchers thought that grapevines could be modified to have more hexose transporters to increase the size and quality of grapes.

Explain why increasing the number of hexose transporters could be commercially important to growers of grapevines.

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..... [2]

4 Food crops such as barley and wheat contain gluten. Gluten contains two proteins, glutenin and gliadin.

(b) Coeliac disease is a condition in which the immune system of a person responds to gluten in their diet.

In coeliac disease, there is a response to the presence of peptides (short chains of amino acids) that are produced as a result of gliadin digestion.

(i) The gliadin peptides produced as result of digestion are often as large as 33 amino acids in length. Intestinal cells take up large numbers of these peptides at the same time.

Suggest **and** explain how gliadin peptides are transported into intestinal cells.

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.....
..... [2]

6(c) State **one** role of glycoproteins in the cell surface membrane.

.....
..... [1]

- 1 Scientists measured the concentration of sodium ions and potassium ions in the red blood cells and in the blood plasma of a group of people. The results are shown in Table 1.1.

Table 1.1

	mean concentration of sodium ions /mmol dm ⁻³	mean concentration of potassium ions /mmol dm ⁻³
red blood cells	10	100
blood plasma	100	4

- (a) (i) Use the information in Table 1.1 to identify **and** describe the process by which potassium ions enter red blood cells from the blood plasma.

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..... [3]

- (ii) Sodium ions and oxygen molecules enter red blood cells.

State **one** similarity and **one** difference between the processes used by sodium ions and oxygen molecules to enter red blood cells.

similarity

.....

.....

difference

.....

..... [2]

- (b) Scientists studied the uptake of a substance, **F**, by human red blood cells.

The red blood cells were immersed in a solution of substance **F** for 30 minutes. After this time the scientists recorded two observations:

- the cell surface membrane of the red blood cells showed infoldings (invaginations)
- an increase in the number of vesicles in the cytoplasm.

Identify the process by which substance **F** entered the red blood cells.

..... [1]

2(b) The cell in Fig. 2.1 releases ghrelin, a small protein that acts as a cell signalling molecule.

Fig. 2.2 shows the sequence of amino acids in a ghrelin molecule.

The amino acid serine (Ser) in position 3 in Fig. 2.2 has been modified by the addition of a saturated fatty acid chain.

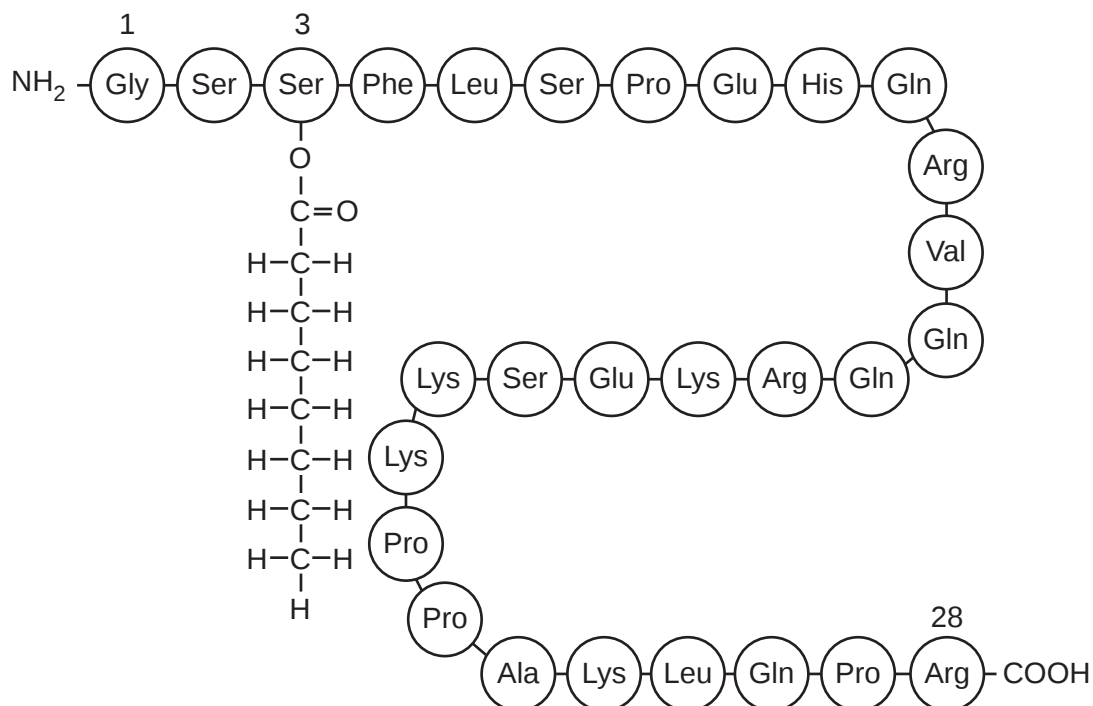


Fig. 2.2

(iii) The addition of the fatty acid chain allows ghrelin to function as a cell signalling molecule.

Suggest how the addition of this fatty acid chain allows a ghrelin molecule to act as a cell signalling molecule.

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..... [3]

5(b) The walls of alveoli contain some specialised epithelial cells called type II epithelial cells. These cells secrete surfactant. Surfactant helps to prevent the alveoli collapsing during breathing.

Surfactant contains phospholipid, cholesterol and protein.

The components of surfactant are synthesised in the rough endoplasmic reticulum and smooth endoplasmic reticulum and then passed to the Golgi body.

The surfactant that is produced is stored in secretory organelles called lamellar bodies.

The surfactant in the lamellar bodies is released onto the surface of the alveolar epithelium by exocytosis, as shown in Fig. 5.2.

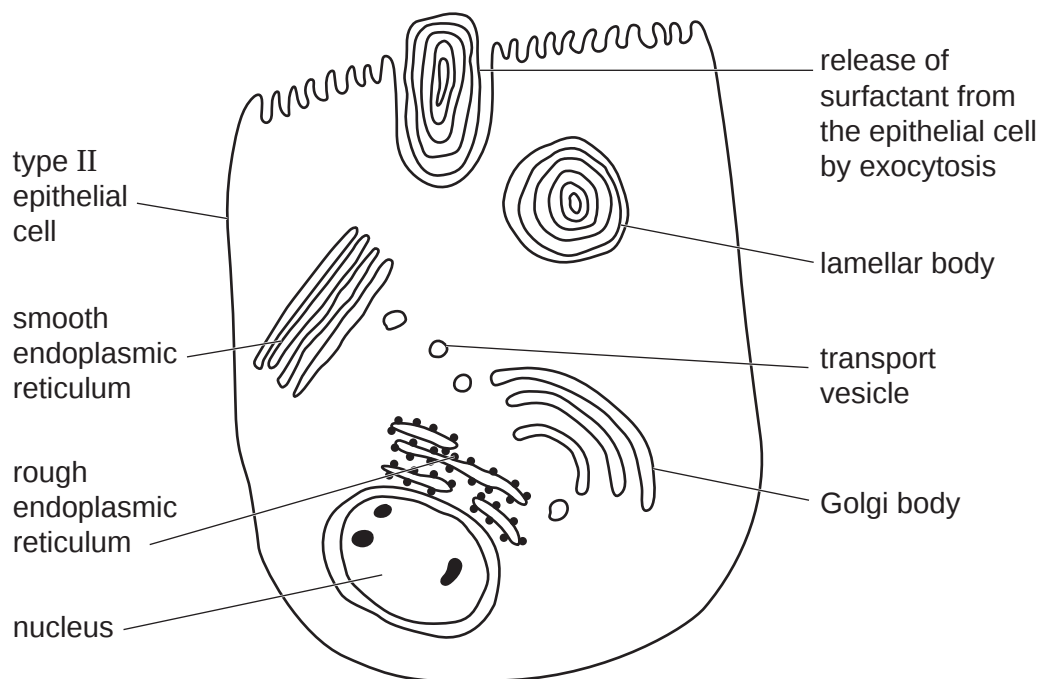


Fig. 5.2

(i) Each lamellar body is surrounded by a single membrane.

Draw a diagram to show the arrangement of phospholipid molecules in the membrane surrounding the lamellar body.

[2]

- (ii) Scientists studying the production and secretion of lung surfactant have discovered that a reduction in cholesterol in the cell surface membrane of type II epithelial cells reduces the secretion of surfactant.

Suggest why secretion of surfactant is affected by a reduction in cholesterol in the cell surface membranes of type II epithelial cells.

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..... [2]

- 2 Glucose is used in the synthesis of amylose. Glucose is first converted to glucose 1-phosphate (G 1-P).

Starch phosphorylase is an intracellular enzyme that can catalyse the synthesis of amylose from G 1-P, which is the substrate for the reaction:



n = a large number

Students used a colorimeter to investigate the progress of the reaction.

The students made a reaction mixture containing 0.01 mol dm^{-3} G 1-P in a buffer solution at pH 6.0. A very small quantity of amylose was added to initiate the reaction.

A solution of starch phosphorylase was added to the reaction mixture and samples were taken at 1-minute intervals. Each sample was added to a dilute iodine solution, stirred and then poured into a cuvette. The absorbance of each solution was recorded.

The results of the investigation are shown in Fig. 2.1.

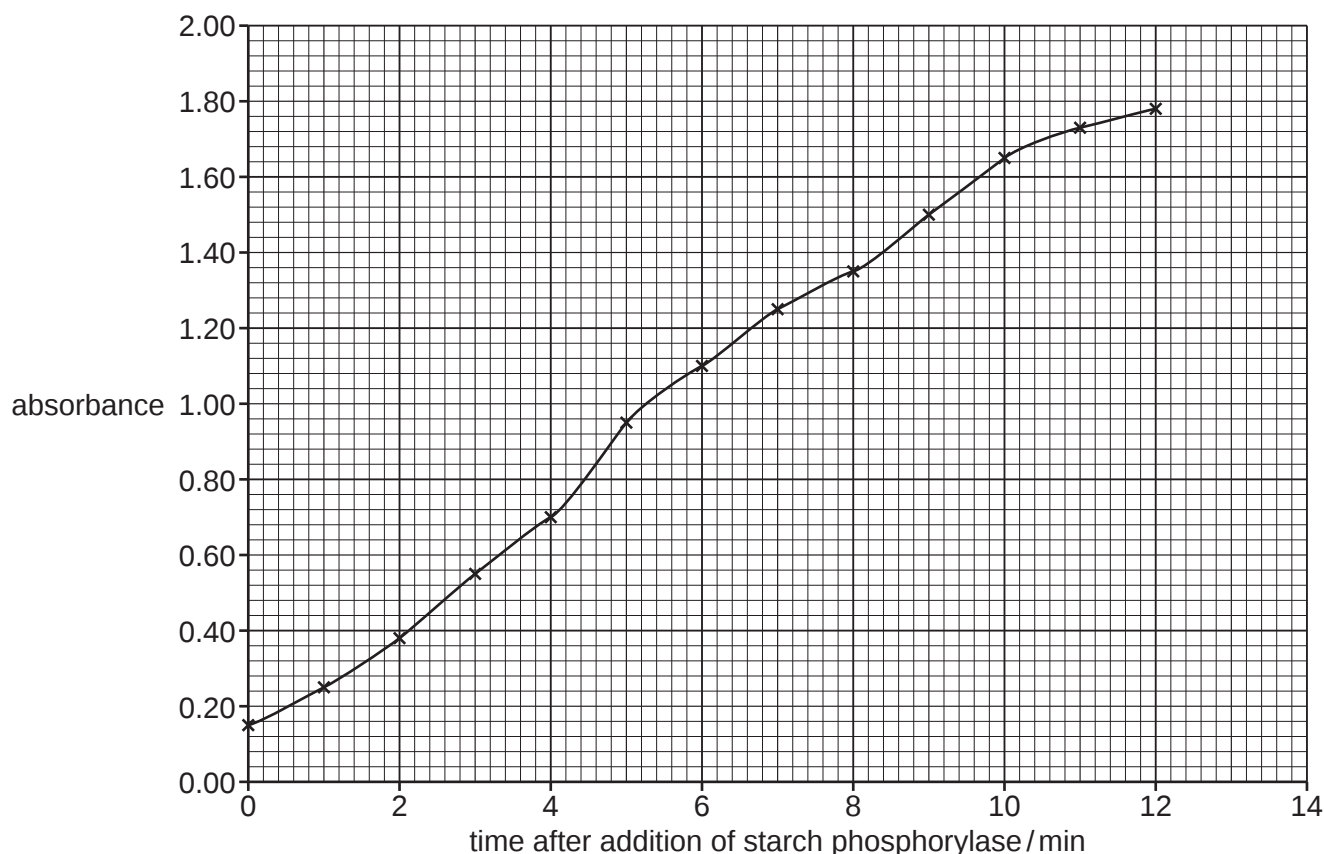


Fig. 2.1

- (a) (i) Explain why the absorbance increases, as shown in Fig. 2.1.

.....

.....

..... [1]

- (ii) The students took their final sample at 12 minutes.

Predict the results for absorbance if the students had continued to take samples for a further 10 minutes. Explain your answer.

prediction

.....

.....

explanation

.....

.....

[2]

- (iii) State an advantage of using a colorimeter in determining the progress of the reaction.

.....

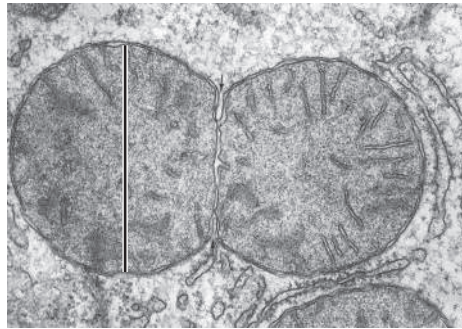
.....

.....

..... [1]

4(c) New mitochondria are formed when a mitochondrion divides into two.

Fig. 4.2 is a transmission electron micrograph of a mitochondrion that is dividing.



magnification $\times 50\,000$

Fig. 4.2

(d) Mitochondrial DNA codes for some polypeptides of proteins used within the mitochondrion. Some of the proteins allow movement of ions into and out of the mitochondria.

Outline the ways in which ions can move into mitochondria.

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.....

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.....

..... [3]

- 1 (a) Fig. 1.1 is a diagram representing part of the phospholipid bilayer of a cell surface membrane.

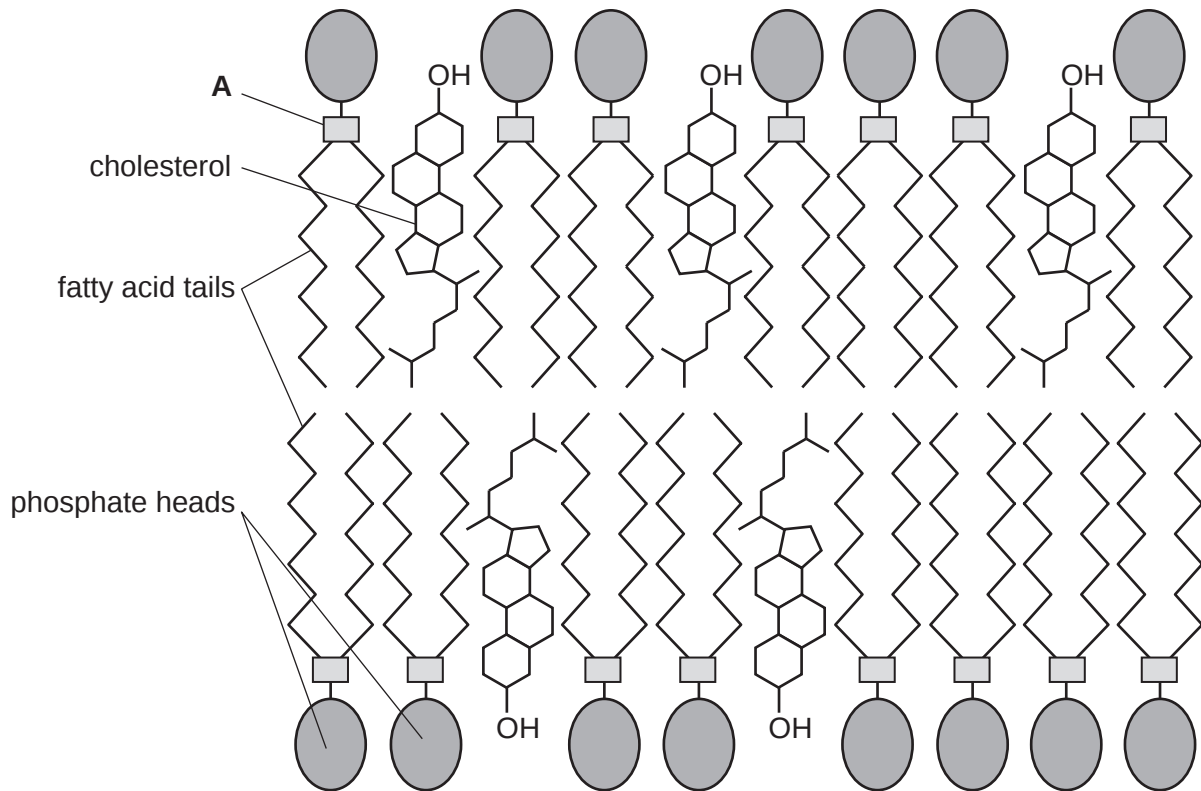


Fig. 1.1

- (i) Identify the part of a phospholipid molecule, labelled **A** in Fig. 1.1, that forms bonds with the phosphate heads and with the fatty acid tails.

..... [1]

- (ii) Cholesterol is an important lipid component of many cell surface membranes. Fig. 1.2 shows the structure of a cholesterol molecule.

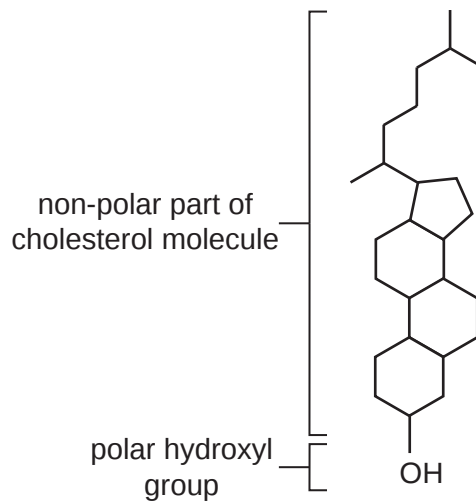


Fig. 1.2

Using the information in Fig. 1.2, explain the orientation (positioning) of cholesterol molecules in the phospholipid bilayer, as shown in Fig. 1.1.

.....

 [1]

- (iii) State **one** role of cholesterol in phospholipid bilayers.

.....

 [1]

- (b) (i) Explain why sodium ions **cannot** cross phospholipid bilayers by simple diffusion.

.....

 [1]

- (ii) Ions and some molecules move across cell surface membranes by facilitated diffusion and active transport.

Compare facilitated diffusion and active transport by stating **one** way in which they are similar and **two** ways in which facilitated diffusion is different from active transport.

similarity

.....

difference 1

.....

.....

difference 2

.....

.....

[3]

- (c) Prostaglandins are small lipids produced in many tissues of the body. One role of prostaglandins is to cause inflammation at the site of an injury or infection. Inflammation is the normal first response of the immune system to injury or infection.

Cyclooxygenase (COX) is an enzyme that catalyses one of the steps in the reaction pathway for the formation of prostaglandins from phospholipids. The reaction pathway occurs in the smooth endoplasmic reticulum (SER) of cells. Part of the reaction pathway is shown in Fig. 1.3.

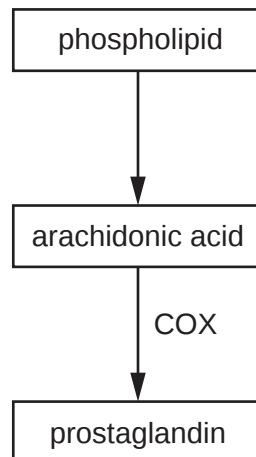


Fig. 1.3

- (i) Suggest an advantage for this reaction pathway occurring in the smooth endoplasmic reticulum of a cell rather than in the cytoplasm.

.....

.....

..... [1]

- (iii) Prostaglandins are examples of cell-signalling molecules.

Outline the process of cell signalling that leads to a response by the cells involved in inflammation.

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..... [2]

1 Fig. 1.1 is a diagram showing part of a cell surface membrane of an animal cell.

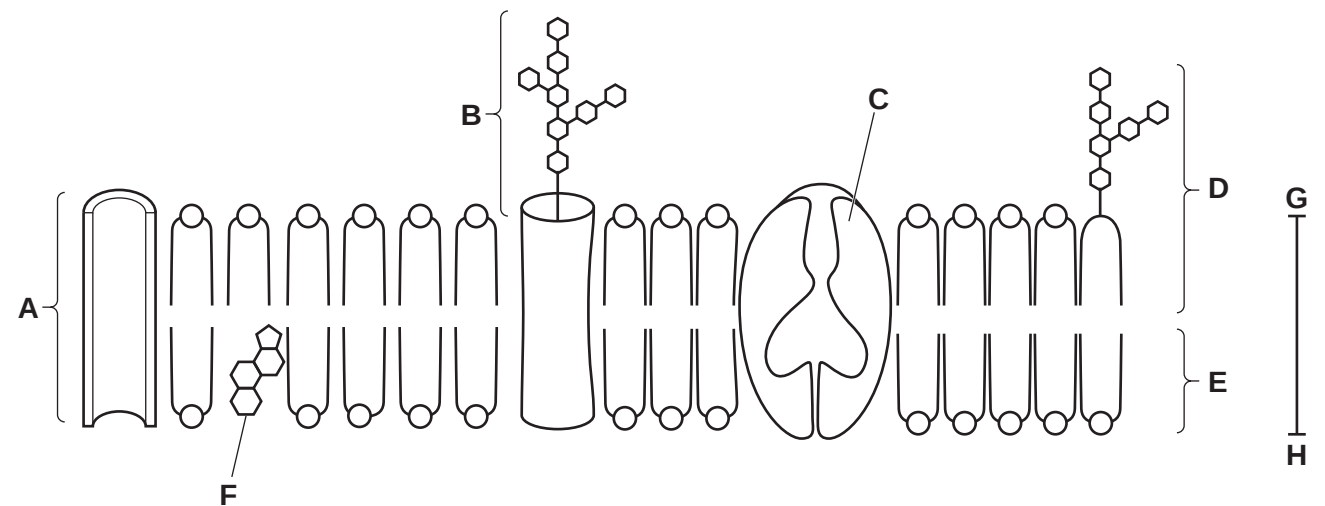


Fig. 1.1

(a) (i) State the approximate thickness of the membrane as shown by the line G–H.

..... [1]

(ii) Complete Table 1.1 to show:

- the names and functions of the components of the cell surface membrane
- the letters of the labels in Fig. 1.1 that identify each component.

Table 1.1

component	function	letter on Fig. 1.1
channel protein		
phospholipid		
	receptor for cell signalling	
		F

[4]

- 4 To investigate nitrate uptake, roots can be cut and removed (excised) and placed in a buffered solution containing nitrate ions. The root tissue can be analysed to determine the quantity of nitrate taken up over a set time period.

(d) Excised roots of the crop plant maize, *Zea mays*, were placed in three different concentrations of nitrate solution: 0.2 mmol dm^{-3} , 1.0 mmol dm^{-3} and 5.0 mmol dm^{-3} .

The solutions were maintained at 30°C and were aerated to provide a continuous supply of oxygen to the root tissue.

Nitrate (NO_3^-) uptake by the root tissue was determined each hour for five hours.

The results are shown in Fig. 4.1.

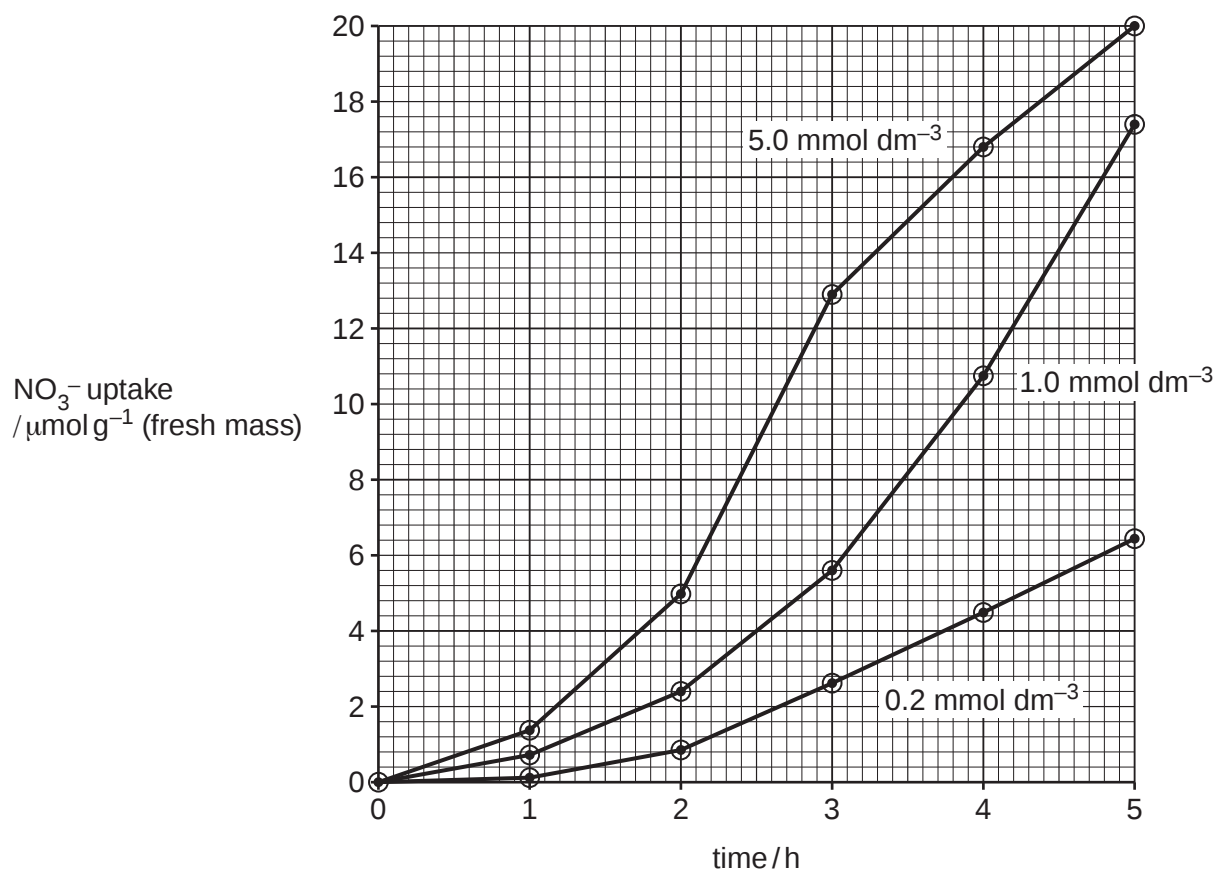


Fig. 4.1

Fig. 4.1 shows that the rate of nitrate uptake is very low initially and then increases for all three concentrations of nitrate solution tested.

Describe the **differences** in the **rates** of nitrate uptake for 5.0 mmol dm^{-3} nitrate solution compared with 0.2 mmol dm^{-3} nitrate solution, between 2h and 5h

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.....

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.....

..... [2]

- (e) The nitrate uptake of excised maize roots was investigated under different conditions.

Table 4.1 shows details and results for a control experiment and four modified experiments, **1**, **2**, **3** and **4**. The same concentration of nitrate solution was used throughout for all the experiments. All the results were taken after a set time period.

Table 4.1

experiment	temperature /°C	aeration	additional substances present in nitrate solution	nitrate uptake / $\mu\text{mol g}^{-1}$ (fresh mass)
1	30	no	nitrogen gas bubbled through instead of oxygen	0.4
2	3	yes	none	0.6
3	30	yes	protein synthesis inhibitor	1.4
4	30	yes	antibacterial compound	10.0
control	30	yes	none	10.9

The results for experiments **1**, **2**, **3** and **4** in Table 4.1 can be compared to the results for the control experiment.

Discuss how comparing each of the results with the control provides information about:

- how nitrate ions are taken up by the root cells
- the factors affecting the uptake of nitrate ions.

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..... [4]

[Total: 17]

Biology 9700-Paper 2 Year 2024 (O/N) Variant 22
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6 The transport of water from the soil solution to the xylem of roots occurs by the apoplast and symplast pathways. Mineral ions can be transported dissolved in water.

(b) Researchers investigated the mechanism of transport used for the uptake of potassium ions (K^+) into root epidermal cells at different concentrations of K^+ in the soil solution.

Complete Table 6.1 to provide information about the two different transport mechanisms that were identified by the researchers.

Table 6.1

net movement of K^+	membrane protein needed (yes or no)	ATP used (yes or no)	name of transport mechanism
against the concentration gradient			
down the concentration gradient			

[3]

Biology 9700-Paper 2 Year 2024 (O/N) Variant 23

- 6 (b) The cholera bacterium releases a protein toxin called cholera toxin. The toxin causes the loss of chloride ions and water from epithelial cells into the lumen of the intestine.

Fig. 6.1 shows the events that occur in cells lining the intestine when cholera toxin binds to the membrane of one of these cells.

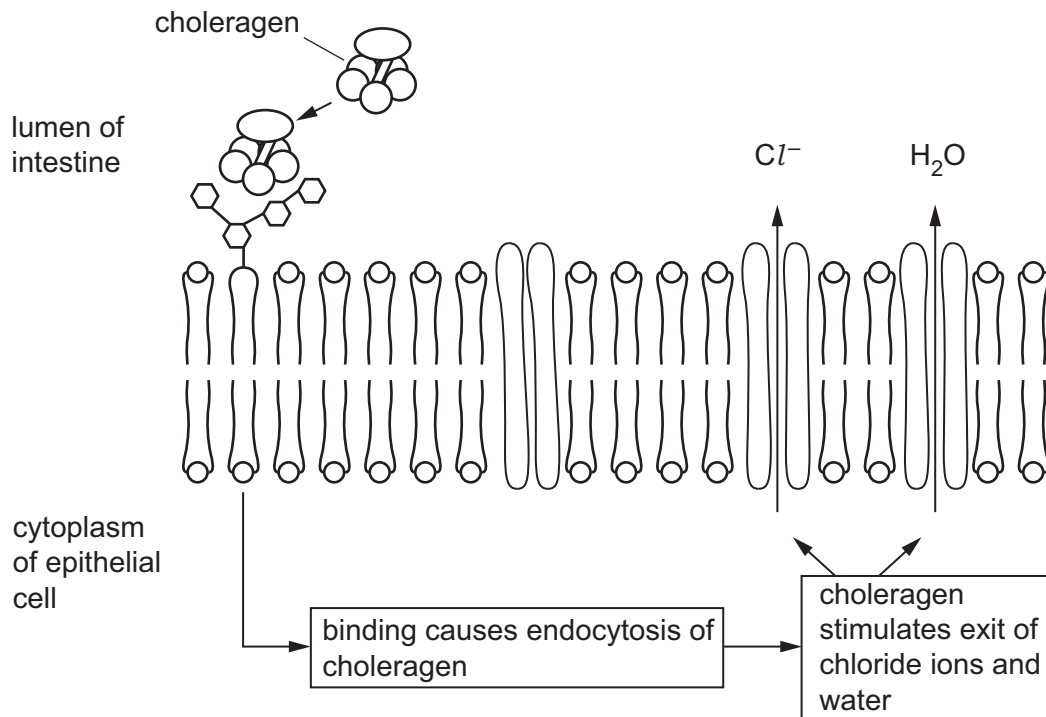


Fig. 6.1

- (iii) State the type of cell membrane component that forms the receptor for cholera toxin.

..... [1]

- (iv) The process by which chloride ions leave the epithelial cell requires energy.

Name the phosphorylated nucleotide that is needed for this process.

..... [1]

- (v) Explain why water also moves from epithelial cells into the lumen of the intestine when cholera toxin is present.

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.....

.....

..... [2]

Biology 9700-Paper 2 Year 2025 (March)

- 1 *Smilax china* is a herbaceous plant.

Fig. 1.1 shows part of a transverse section of a root of *S. china* with root hair cells visible.

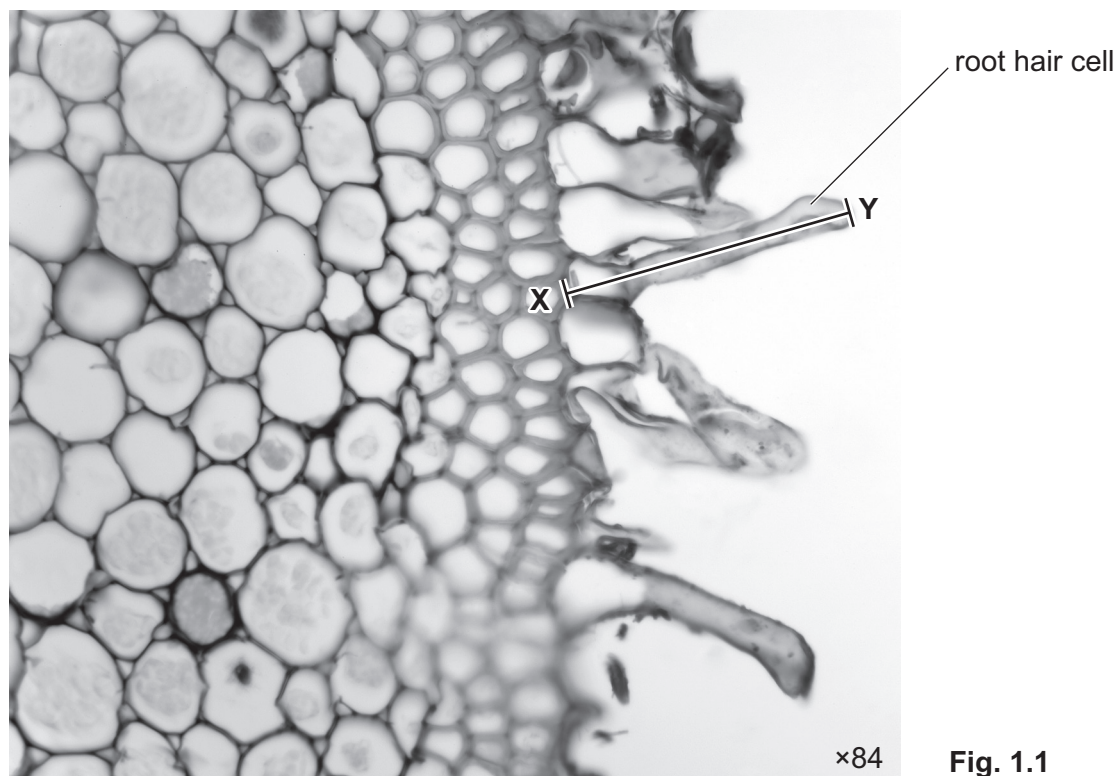


Fig. 1.1

- (d) Mineral ions are taken up by root hair cells.

Table 1.1 shows the concentrations of sodium ions (Na^+) and potassium ions (K^+) inside the root hair cells of a plant root and in the soil solution surrounding the root.

Table 1.1

concentration of Na^+ / g dm^{-3}		concentration of K^+ / g dm^{-3}	
root hair cell	soil solution	root hair cell	soil solution
0.35	3.34	5.46	0.16

With reference to Table 1.1:

- suggest the mechanisms involved in the transport of Na^+ and K^+ from the soil solution into the root hair cells
- state the reasons for your suggestions.

.....

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.....

..... [3]

9700/22/F/M/25

- (ii) Many glycoproteins in the cell surface membrane are involved in cell signalling.

State the role in cell signalling of glycoproteins in cell surface membranes.

.....
.....
..... [1]

Biology 9700-Paper 2 Year 2025 (M/J) Variant 21

- 2 In mammals, the small intestine is the main site of absorption of the products of digestion.

Fig. 2.1 is a transmission electron micrograph of a longitudinal section (L.S.) of part of an epithelial cell from the small intestine of a mammal.

Fig. 2.2 is a transmission electron micrograph of a horizontal section made at the position indicated by the two arrows in Fig. 2.1.

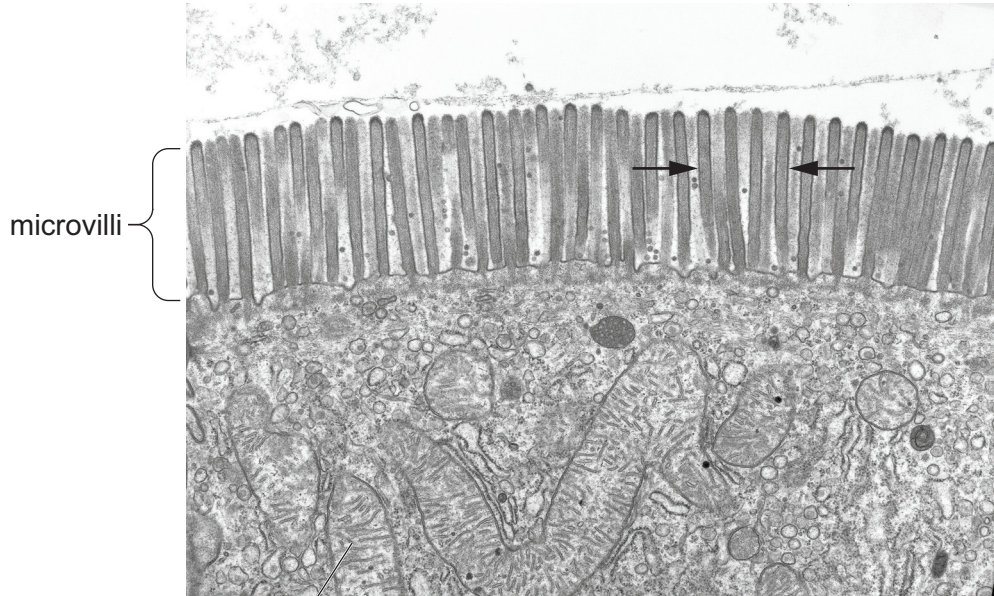


Fig. 2.1

magnification $\times 12\,500$

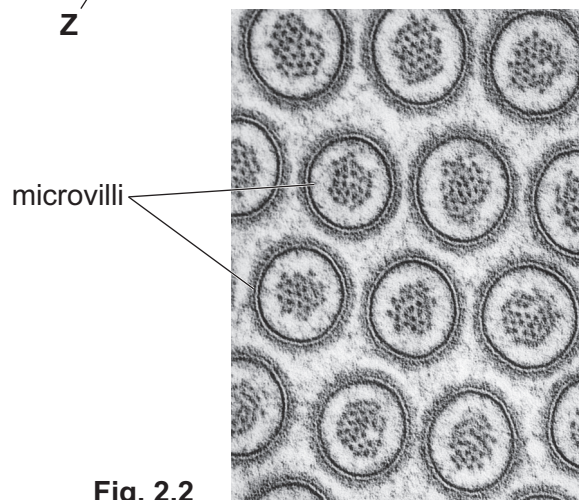


Fig. 2.2

magnification $\times 50\,000$

- (b) A scientist measured the length and the diameter of some of the microvilli shown in Fig. 2.1 to estimate the total surface area of microvilli on the surface of the epithelial cell.

The scientist assumed that each microvillus was cylindrical in shape.

Suggest **one** other measurement needed to estimate the total surface area of the microvilli of the epithelial cell.

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.....

..... [1]

Biology 9700-Paper 2 Year 2025 (M/J) Variant 23

4 Lysosomes are membrane-bound organelles found in mammalian cells.

- (a) Scientists measured the concentration of cholesterol in the membranes of lysosomes in a mammalian cell.

The concentration of cholesterol in the lysosome membranes was found to be lower than the concentration in other membranes inside mammalian cells.

- (i) State how a lower concentration of cholesterol would make the properties of lysosome membranes different from other membranes in mammalian cells.

.....
.....
..... [1]

- (ii) Suggest why the lower concentration of cholesterol in lysosome membranes would help lysosomes carry out their function.

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..... [1]